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Soil Survey

of

McIntosh County, Oklahoma

By

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United States Department of Agriculture, in Charge
and
O. H. BRENSING
Oklahoma Agricultural Experiment Station

Bureau of Chemistry and Soils

In cooperation with the
Oklahoma Agricultural Experiment Station

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SOIL SURVEY OF McINTOSH COUNTY, OKLAHOMA

By E. W. KNOBEL, United States Department of Agriculture, in Charge, and O. H. BRENSING, Oklahoma Agricultural Experiment Station

COUNTY SURVEYED

McIntosh County is in the eastern part of Oklahoma (fig. 1). Eufaula, the county seat, is about 60 miles west of Fort Smith and the Arkansas State line and about the same distance southeast of Tulsa. The county includes an area of 708 square miles, or 453,120 acres.

Physiographically the county is modified, because of its occurrence on the border of the Ouachita province and at the southern terminus of a great belt of ever-narrowing prairie land extending southward from Kansas. A large proportion of the county comprises high rough stony ridges and hills, which occupy most of the eastern and the western parts, and the central part is rolling prairie land, together with a few small bodies of stony hills.

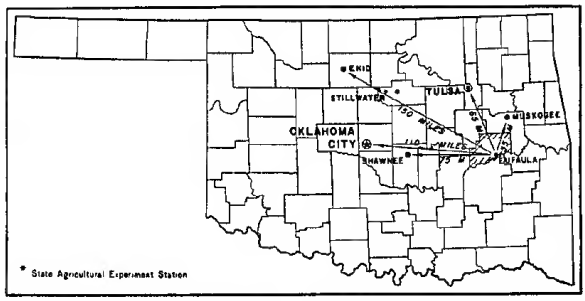

FIGURE 1.—Sketch map showing location of McIntosh County, Okla.

The prairies for the most part range from very rolling to undulating. There are some fairly smooth areas, through which many streams have cut narrow valleys. Along these streams the slopes range from steep to moderate. The rough lands include sandstone ridges and hills with steep stony slopes, and in places these areas lie several hundred feet above the intervening valleys and are locally called mountains. Several rough stony forested hills rise from 75 to several hundred feet above the level of the streams.

The rough terrain on the western boundary is dissected by three rivers flowing eastward. In order of size, these are Canadian River, which forms the entire southern boundary; North Canadian River, which enters the county in the west-central part; and Deep Fork, which enters in the northwestern part.

The alluvial lands along these streams include both first bottoms and second bottoms, or terraces, most of which lie from 25 to 30 feet above the first-bottom land. The land comprising the distinctly higher terraces has been above overflow a long time, and considerable areas of it are greatly dissected by erosion and constitute rolling

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lands topographically similar to the soils of the upland overlying the sandstone and shale formations.

The stream bottoms differ greatly in width. Because of the low gradient of Deep Fork for the first 8 miles after entering the county, the bottom land along this stream ranges from 1 to 2½ miles in width. North Canadian River, which meanders through several miles of hilly country after entering the county, has a flood plain ranging from one-fourth to 1 mile in width, with little second-bottom land, but this valley gradually widens after leaving the higher rough land. Below the confluence of the two rivers, 6 miles north of Eufaula, the first-bottom land is bordered by wide areas of second bottoms, or terraces, which join similar terraces along Canadian River. The Canadian River bottom averages more than a mile in width.

The gradients of the larger streams in general are not pronounced but are fairly uniform. In the vicinity of Standing Rock, on Canadian River several miles east of Eufaula, the gradient is greater. Most of the streams have reached base level and are not actively cutting their channels, although the channel of Canadian River is much wider than formerly because of large accumulations of sand and the constant changing of the river channel.

The native vegetation of the prairies consists largely of several species of *Aristida* and *Andropogon*, which are coarse bunch grasses. These grasses, locally known as poverty grass and broomsedge, respectively, are common in abandoned fields and on overgrazed lands, and persimmon shrubs are common on the eroded sandy soils. In poorly drained areas, sedges and sloughgrasses prevail, and small willow and sycamore trees are abundant. In the rough and stony areas a growth of blackjack oak, post oak, and hickory trees make up the forest, with some haw, elm, and persimmon, and in places in the northeastern part of the county there is a scattered growth of pine. In the stream bottoms, elm, water oak, pin oak, spotted oak, sycamore, locust, walnut, hickory, birch, pecan, and ash are the most common trees, and on the sandy terraces post oak, blackjack oak, and hickory trees predominate.

McIntosh was one of the seven original counties formed when Oklahoma Territory was created in 1890. It was then occupied mainly by Creek and Cherokee Indians, and it was organized from these Indian nations in 1907; part of Hughes County was annexed in 1915, and part of McIntosh County was annexed to Okmulgee County in 1918. McIntosh County was named in honor of the noted McIntosh family who were Creek Indians.

According to the Federal census, the population of the county was 20,961 in 1910, 26,404 in 1920, and 24,924 in 1930. All is classed as rural, as no town has more than 2,500 inhabitants. The average density of the population is 35.2 persons to the square mile. In 1930, 4,448 of the inhabitants were colored, and practically all the people in Vernon and Rentiesville are colored. The other towns have not only some colored people but a rather large percentage of Indians. The original white population migrated largely from the bordering States on the east and south. Eufaula, the county seat, is in the southern part of the county, and Checotah, an important town, is in the northeastern part. In 1930 the population of Eufaula was

2,073 and of Checotah 2,110. Smaller towns are Texanna, Hitchita, Hanna, Vernon, Rentiesville, Lenna, Stidham, Richardsville, and Onapa.

The Missouri, Kansas and Texas Railroad, which passes through Eufaula and Checotah, was opened to traffic on January 1, 1872. The Kansas, Oklahoma & Gulf Railway passes through the northwestern part of the county, and the Fort Smith and Western Railway through the southwestern part. These three railways afford ample transportation facilities for farm commodities, and few farms are more than 12 miles from a shipping point.

The public roads are, for the most part, only fair. Because of the high erosivity of the soil, ditches readily start along the roads, and consequently their upkeep is a growing problem. Because of insufficient funds for road work, many roads are practically ruined, and some are very rough and nearing abandonment. Most of the public roads, however, are in fairly good condition during dry periods but are difficult to travel during wet periods. United States Highway No. 69, connecting Eufaula and Checotah, is graveled and in good condition, and United States Highway No. 266, passing east and west through Checotah, is being graveled. The 1930 census reports only one farm located on a concrete road. There are 46 on gravel, 2 on macadam, 10 on asphalt, 13 on sand-clay, 1,506 on improved dirt, and 1,579 on unimproved dirt roads, and 360 farms are not accounted for.

Churches and public schools are fairly numerous. Several school busses carry children to and from the consolidated schools and the larger town high schools. Only 241 telephones were reported on farms in 1930. The same census reported 1,012 automobiles, 149 trucks, and 34 tractors on the farms.

CLIMATE

The climate is continental and is characterized by wide, and often sudden, changes in temperature. Ordinarily the summer season is hot, and dry periods are frequent. The winters are usually mild, and extremely cold weather is rare. A few snow flurries occur during most winters but are of short duration. The spring season is rather windy but pleasant, and the rainfall is more abundant than at other seasons of the year. At least 60 percent of the average annual rainfall of 39.63 inches falls during the growing season, from April to September, inclusive. During this period, heavy showers of short duration prevail, but during the winter, long-continued light rains are common. Occasionally prolonged droughts occur during the growing season.

The average date of the last killing frost is March 28, and of the first is October 30, giving a frost-free season of 216 days. Frost has been known to occur as late as April 21 and as early as September 29. Formerly much greater numbers of peach and other fruit trees were grown, but the risk of late spring frosts or winter-killing has caused some of the farmers to cease attempts at growing fruit trees, especially peach trees. Berries and garden vegetables are seldom injured by frost unless planted entirely too early to conform to the average date of the latest spring frost. Local hailstorms occur at times, but crop losses from hail are small in comparison to injury from other causes.

In addition to natural soil fertility, the amount and distribution of the rainfall is the principal factor in producing good crop yields. The capacity of the soils to absorb and retain moisture is of great importance in many soils of this county, as one cause of low yields is the inability of some of the soils to absorb and retain the local rainfall. In many places this is owing to the sloping land surface which causes the soil to erode easily and lose, through erosional wastage, a large part of the loose rich topsoil, leaving a thin layer of soil material of very low absorptive capacity.

Occasionally a hot dry wind causes sufficient injury to reduce the crop yields greatly, regardless of soil conditions, but the average yearly losses produced by this climatic factor are small, compared with those caused by erosion. Hot dry weather is the most common climatic agency affecting the final yield. Ordinarily small grains are more severely injured a week or two prior to harvesting, and growing corn may be greatly injured by lack of rain, even when it is in excellent condition up to the tasseling stage. Grain sorghums and cotton are the most drought-resistant crops commonly grown. They can withstand hot winds or long dry periods better than any other cultivated crop.

Table 1, compiled from records of the Weather Bureau station at Eufaula in the southern part of the county, gives the more important climatic data. These are considered fairly representative for all sections of the county.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Eufaula, McIntosh County, Okla.*

[Elevation, 566 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1891)	Total amount for the wettest year (1927)	Snow, average depth
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	42.2	77	−7	2.44	3.10	2.57	1.8
January	40.2	77	−15	2.53	1.73	5.31	1.7
February	43.6	89	2	1.81	1.20	2.18	.6
Winter	42.0	89	−15	6.78	6.03	10.06	4.1
March	50.4	93	18	2.83	1.40	3.46	.5
April	61.2	92	18	4.67	2.40	10.66	0
May	68.7	95	34	5.56	4.50	4.56	0
Spring	60.1	95	18	13.06	8.30	18.68	.5
June	77.4	105	43	3.53	3.67	4.85	0
July	81.6	108	50	2.96	5.16	7.61	0
August	81.6	109	46	4.09	1.80	9.84	0
Summer	80.2	109	43	10.58	10.63	22.30	0
September	73.3	105	30	3.23	.25	2.47	0
October	62.6	94	15	3.20	.25	5.02	0
November	52.8	86	14	2.78	1.20	2.77	.3
Fall	62.9	105	14	9.21	1.70	10.26	.3
Year	61.3	109	−15	39.63	26.66	61.30	4.9

AGRICULTURAL HISTORY AND STATISTICS

Prior to general settlement, McIntosh County was one of the counties included in the territory allotted to the Creek and Cherokee tribes of Indians. Later, the Indians were allotted land individually but were not allowed to dispose of any part of their allotment. Subsequently these restrictions were removed, and the Indians were allowed to sell all their property except the homestead which included 40 acres. Settlers began purchasing the unallotted land, and later considerable land allotted to individual Indians changed hands.

Neither the early white settlers nor the Indians practiced intensive agriculture. They grew some corn and depended largely on cattle raising, hunting, and fishing for their supply of meat.

The valley lands along Canadian and North Canadian Rivers and the larger creeks were the first to be cultivated. Later, some of the prairie and wooded lands were gradually put under cultivation. The small patches in the hilly areas and the extremely sandy upland bordering Canadian River were the last to be cultivated.

The early settlers soon learned that corn and cotton were the two most dependable crops for the bottom lands. These crops, however, were grown indiscriminately throughout the county. Oats and other small grains, including a small quantity of wheat, were and still are grown, mainly on the smooth Prairie soils. Later alfalfa, broomcorn, grain sorghums, millet, velvetbeans, soybeans, and cowpeas were grown.

The 1935 census reports 3,410 farms in the county. Of these, 2,720 were operated by white farmers and the rest by Indians and Negroes. The approximate land area in the same year was 453,120 acres, of which 72.8 percent, or 329,907 acres, was in farms. The average size of the farms was 96.7 acres. The size of farms ranges from 3 acres or less to more than 5,000 acres. The greater number of farms are between 20 and 175 acres. Various types of farming are practiced.

According to the Federal census, the total amount of land available for crops in 1934 was 206,587 acres. This included land from which crops were harvested, or on which they were a failure, also idle, fallow, and plowable pasture land. The total pasture land amounted to 106,709 acres, of which 19,723 acres were plowable pasture, 49,127 acres woodland pasture, and 37,859 acres all other pasture.

In 1935, 542, or 15.9 percent, of the farms were operated by full owners; 194, or 5.7 percent, by part owners; 4, or 0.1 percent, by managers; and 2,670, or 78.3 percent, by tenants, most of whom were croppers. Share and cash systems of rental, as well as a combination of the two, are practiced, but the share system is the most common. Under this system the tenant generally furnishes all equipment and expense of producing the crop and delivers one-fourth of the cotton and one-third of the corn to the owner. On some farms the owner furnishes one-half of the seed. Cash rents differ according to the type of land and the distance from towns and hard-surfaced highways.

The average farmstead and equipment are only fair. On the smooth prairie land most of the homes are well painted and maintained, but those on the rougher land are, as a rule, not well

maintained or well improved. The farm machinery ordinarily consists of plows, disks, harrows, listers, cultivators, wagons, binders, and drills, and much of the farm work is accomplished by mules and Negro labor. A few tractors are in use.

Table 2 gives the numbers of livestock on the farms, as reported by the Federal censuses for 1910, 1920, 1930, and 1935.

TABLE 2.—*Number of livestock on the farms in McIntosh County, Okla., in stated years*

Livestock	1910	1920	1930	1935	Livestock	1910	1920	1930	1935
	Number	*Number*	*Number*	*Number*		*Number*	*Number*	*Number*	*Number*
Horses	6,939	7,768	5,565	4,272	Sheep	-------	101	387	1,006
Mules	3,088	6,255	7,191	5,414	Swine	16,888	22,452	15,757	13,660
Cattle	16,975	19,535	14,808	22,905	Chickens	[1]87,075	135,459	136,386	[2]

[1] All poultry, mainly chickens.
[2] Not reported.

As shown in table 2, both horses and mules are becoming less numerous. Most of the mules, some of which are shipped in and some raised on the farms, are of medium size, and they are used mainly by renters in the production of cotton. Most of the horses are lightweight grade animals. A few are of the heavy draft type.

The raising of cattle is an important phase of agriculture. About one-half of the total acreage of the county is not cultivated and supports a grass vegetation, a tree growth, or both. Such land, which is largely in the western and southeastern parts, is utilized mainly for grazing cattle. Most of the cattle are sold in late summer or early fall when of sufficient size and weight, or when the market is favorable, and some are killed and sold for local needs. The most common breeds of cattle are Jersey, Shorthorn, and Hereford, but many cattle are grades of mixed breeding.

Dairying, although not extensively developed, is carried on by a number of farmers, mainly to supply the local demand. Some milk and cream are shipped. Most of the dairy cows are of good strains of Jersey breeding. Most of the farmers own at least enough cows to supply the needs of their family.

A few farms are devoted exclusively to the raising of poultry, and nearly every farmer keeps some chickens. The average-sized farm flock includes between 50 and 100. The most common breeds of chickens raised are Rhode Island Red, White Leghorn, Brown Leghorn, Barred Plymouth Rock, and White Plymouth Rock.

A few farmers specialize in raising hogs for market, and most farmers raise a few for home consumption. Some usually have a few extras to sell on the market. Duroc-Jersey is the most common breed, but some Hampshire, Poland China, Chester White, or crosses of these breeds are raised.

Only a few goats and sheep are raised, and a few colonies of bees are kept.

Table 3, compiled from the Federal census reports, gives the acreage of the principal crops grown in 1909, 1919, 1929, and 1934.

TABLE 3.—*Acreage of the principal crops in McIntosh County, Okla., in stated years*

Crop	1909	1919	1929	1934	Crop	1909	1919	1929	1934
	Acres	*Acres*	*Acres*	*Acres*		*Acres*	*Acres*	*Acres*	*Acres*
Cotton	41,934	76,834	30,236	52,181	Sorghums for grain	78	271	1,209	2,501
Corn	78,212	56,978	70,750	56,739	Tame hay	502	2,282	833	[1] 16,915
Oats	4,602	36,123	6,217	6,538	Alfalfa	43	611	345	579
Wheat	94	4,583	173	83	Small grains for hay	15	1,371	209	318
Potatoes	455	231	730	845	Legumes cut for hay	-------	222	886	2,538
Sweetpotatoes	78	262	260	284	Wild hay	5,702	5,008	3,585	(2)
Peanuts	8	109	2,837	-------	Sorghums for hay or fodder	22	3,126	1,336	5,400

[1] All hay and sorghums for forage.
[2] Not reported separately.

About 75 percent of the farms are devoted mainly to growing cotton, the most important crop. Cotton is and has been for many years the chief money crop. Prior to 1910, when the soils of this county were agriculturally new, the acreage in cotton was about half that in corn, but since that time the total acreage in cotton has increased. Past experience has proved that cotton is better suited to the climatic and especially to the changing soil conditions than is corn. Yields of a bale or more an acre of cotton have been reported, but at present, due to the boll weevil and also to the impoverished condition of the soils on many farms, the average yield for this county is less than one-fourth bale in some years. Among the cotton varieties best suited to the prevailing conditions are Early Triumph, Acala, and Nucala, named in order of their importance.

Corn ordinarily ranks second to cotton in acreage, but in 1934 the acreage in corn exceeded that in cotton by about 4,000 acres. The greater part of the corn is consumed locally by work animals and cattle, and some is ground into meal for home use. Yields on the upland soils are said to have declined greatly. The midseason varieties most commonly grown are Midland Yellow Dent, Pride of Saline, White June, and Oklahoma; the early varieties include Waughs Early Yellow, Funks 90-day, Hays Golden, and Colby Bloody Butcher.

Soybeans and cowpeas are grown to a slight extent. In some cornfields every third row is planted to soybeans or cowpeas (pl. 1, *A*). This allows enrichment of the soil by the legumes, which more than offsets the amount of corn lost in every third row. Farmers claim that the total corn yield is only about 10 percent lower than when every row is planted to corn. The varieties of soybeans suitable for this locality are Chiquita, Virginia, Laredo, and Wilson, and of cowpeas are Whippoorwill, Clay, Iron, Red Ripper, Brabham, and many others.

A few tame-hay crops, such as oats cut green, sweetclover, Sudan grass, timothy, and grain sorghums are grown for local needs only. Alfalfa, although a highly desirable crop for this section, is not grown extensively, because of the small proportion of soils suited to its requirements. Grimm is the variety more commonly grown.

Oats are grown, both as a green-hay crop and a small-grain crop, and some are pastured. This crop matures early on the heavy clay-pan soils which are not so well suited to corn. The favorite varieties

of oats are Kanota, Columbia, Fulghum, and Red Rustproof (Red Texas).

Wheat, rye, and barley are crops of very little importance. The principal varieties of wheat are Harvest Queen, Fulcaster, and Kawvale.

Potatoes are grown mainly for consumption in the home, but a few farmers near Hanna specialize in shipping early potatoes to northern markets, and they also grow a fall crop. The most common varieties grown are Early Ohio, Green Mountain, Irish Cobbler, and Bliss Triumph. Sweetpotatoes are grown mainly for home use. The sandy first- and second-bottom soils and the sandy upland soils with fine sandy clay subsoils are well suited to this crop. The growing of garden vegetables is of some commercial importance, but most of the farmers grow various vegetables for home use only. Near Hanna, a few farmers specialize in growing early spring onions, string beans, tomatoes, melons, and cucumbers for shipment.

Grape growing is increasing. The acreage devoted to grapes could be greatly increased, probably on some soils to much better advantage than that of most other crops. Such orchard crops as cherries, peaches, pears, plums, and apples are commonly grown, mainly for home consumption. More attention is being paid to the commercial production of pecans. The decline in the acreage devoted to orchard fruits is attributed mainly to late spring frosts, and to the fact that a number of soils are not suited to fruit trees because of their heavy, impermeable subsoils. A few acres are in strawberries, blackberries, and raspberries, which are produced mainly for home use.

Up to the present, commercial fertilizers have not been generally used. It is possible that they will be used much more extensively in the future, on some of the soils, especially for cotton and truck crops. It is reported locally that an acre application ranging from 300 to 500 pounds of a 4–8–6 [1] or 4–8–10 mixture has proved beneficial for early truck crops, especially potatoes, and that only about 200 pounds are necessary for string beans and onions.

SOILS AND CROPS

Approximately 45 percent of the county is arable, or plow, land suited to intertilled crops, and the remainder, consisting largely of steep ridges and rough land, chiefly in the western third of the county, is too rocky and steep for cultivation.

A number of distinct soil types, differing greatly in chemical and physical composition, have developed over the several materials produced by weathering of the rocks, largely sandstones and shales. Although the important characteristics of the soils are due to the native vegetation and the climate, inasmuch as climatic conditions vary little within the county, the soil differences within the area are caused mainly by the character of the underlying parent material and the relief. The rougher areas, which include stony loams and rough stony land, are utilized for grazing, whereas the smoother areas, which are largely very fine sandy loams, are utilized chiefly for intertilled crops.

[1] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

The arable, or plow, land consists of both dark-colored and light-colored soils. The dark-colored Prairie soils are most extensively developed in the northern part of the county and have developed under a grass cover. The dark-colored alluvial soils of the high and low terraces apparently have developed from the finer sediments deposited in the more quiet backwaters during periods of high overflows in the past, and their dark color is indicative of a high content of organic matter which produces several beneficial effects. It assists the soil in absorbing the sun's heat; it greatly increases the water-holding capacity, thereby insuring considerable protection against crop failure during droughts; it retards destructive erosion on the more pronounced slopes; and it helps to maintain a desirable tilth. Organic matter is the chief source of nitrogen—one of the most important plant nutrients for growing crops.

In the north-central part of the county the land surface is smooth, with very slight undulations, and here the parent material consists of a combination of fine-grained sandstone and shale, from which have developed soils with distinct claypan subsoils and gray or grayish-brown topsoils. Surface drainage and underdrainage are very slow, and these soils are more thoroughly leached of their mineral constituents.

The upland soils bordering the larger stream bottoms, such as those along North Canadian and Canadian Rivers, have been modified by sediments deposited during periods of extremely high overflows. They have grayish-brown and reddish-brown surface soils and either light-colored very fine sand or reddish-brown very fine sandy clay subsoils which in many places show stratification caused by water. The sediments forming the mantle of old high terraces were transported from soils farther west, where the average annual rainfall is much less and the soils are less leached of their lime; consequently, some of these soils probably still contain considerable lime in the lower part of the subsoil and, in many places, near the surface, because the leaching process has not kept pace with natural erosion. The alluvial soils are extremely variable in color, texture, surface features, and mineral constituents. The content of lime and organic matter probably is higher than in most of the upland soils of similar texture.

Most of the tillable soils, with the exception of those of a few first bottoms and second bottoms, are not highly productive. This is partly owing to the soil characteristics and the climatic environment. The fact that a high percentage of the cultivated land originally was forested is sufficient evidence that the topsoil is low in organic matter and nitrogen, as a forest cover does not furnish a large supply of these materials. Even the better dark-colored Prairie soils are less productive than they were 20 years ago, mainly because of a lack of farm practices designed to conserve productiveness.

Most of the cultivable soils are responsive to fertilization and correct management. Although comparatively little commercial fertilizer has been used, it has proved profitable on certain soils for certain crops. On the more sloping and severely eroded fields, terraces are needed in addition, in order that crops may be grown without loss of soil through erosion. The growing of leguminous crops, especially when turned under as green manure, has greatly increased the productiveness of some of the soils.

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The chief crops grown are cotton, corn, oats, wheat, alfalfa, grain sorghums, and hay, and the farmers in a few localities specialize in growing truck crops. With the exception of alfalfa, all the crops common to this county are grown to greater or less extent on both upland and bottom-land soils, but the yields differ greatly. Corn is better suited to the dark-colored upland and bottom-land soils than to the lighter colored upland and extremely sandy bottom soils, mainly because of the high organic-matter content and friable permeable character of the subsoils which afford better root development and conserve soil moisture more effectively. Oat yields, although not so high on the light-colored as on the dark-colored upland soils, are relatively more satisfactory than those of corn on the light-colored soils, especially those having claypan subsoils. Cotton is grown on all types of soils, but it is least productive on the light-colored upland soils with claypan subsoils and on the extremely loose, light, sandy alluvial soils. Past experience has proved that cotton is better suited to the climatic and soil conditions than corn, as it can withstand more dry weather in late summer and can produce a relatively higher yield on badly eroded and otherwise impoverished soil than corn. Where land has been poorly managed and has lost a part of the rich topsoil and its supply of organic matter, the yield of corn is reduced more than that of cotton, on all soil types. Owing to the ability of cotton to withstand adverse soil and climatic conditions and because it is the most certain cash crop, its acreage steadily increased from year to year until 1929. It is now grown on all the arable soils of the county, though more extensively on the better soils.

Alfalfa does best on the soils of the first and second bottoms, because of the prevailingly high ground-water level and the abundance of lime in the subsoil. Practically all the upland soils are acid and ordinarily require liming before alfalfa can be satisfactorily grown. Some of the claypan soils, although they contain lime in the lower part of the subsoil, are not suited to alfalfa because of the stiff claypan layer.

Melons, peanuts, onions, potatoes, and other truck crops do best on the well-drained sandy soils having sandy clay subsoils.

Many soils appear very similar on casual observation, but careful examination of the subsoil discloses highly significant differences which may cause pronounced differences in crop adaptation and yields. Inasmuch as some of the types mapped have somewhat similar soil characteristics and crop adaptations, they may be grouped, according to their general characteristics and agricultural relationships, as follows: (1) Prairie soils with moderately friable subsoils; (2) Prairie soils with claypan subsoils; (3) forested upland soils; (4) dark-colored soils of the second bottoms, or terraces; (5) well-drained alluvial soils; (6) imperfectly drained alluvial soils; and (7) miscellaneous soils and land types.

In the following pages, the groups of soils and the individual soil types are described, and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 4.

TABLE 4.—*Acreage and proportionate extent of the soils mapped in McIntosh County, Okla.*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Bates silt loam	31,232	6.9	Verdigris very fine sand	2,496	0.5
Bates fine sandy loam	50,304	11.1	Verdigris very fine sandy loam, colluvial phase	2,496	.5
Bates silty clay loam	12,800	2.8	Yahola very fine sandy loam	4,992	1.1
Bates loam, reddish-subsoil phase	4,736	1.0	Lincoln fine sand	2,048	.4
Parsons silt loam	35,392	7.8	Perry silty clay	5,824	1.3
Parsons very fine sandy loam	14,400	3.2	Perry silty clay, better drained phase	1,024	.2
Parsons very fine sandy loam, deep phase	2,560	.6	Lightning silty clay loam	3,648	.8
Parsons very fine sandy loam, slope phase	14,400	3.2	Lincoln very fine sandy loam, poorly drained phase	1,088	.2
Teller fine sandy loam	896	.2	Yahola silty clay loam, depression phase	768	.2
Teller fine sandy loam, rolling phase	23,552	5.2	Verdigris soils, undifferentiated, depression phase	704	.2
Stidham very fine sandy loam	9,280	2.0	Hanceville stony loam	92,864	20.6
Stidham fine sand	13,120	2.9	Talihina clay loam	2,304	.5
Stidham loamy fine sand	3,072	.7	Talihina stony clay loam	14,080	3.1
Hanceville fine sandy loam	40,000	8.8	Parsons very fine sandy loam, eroded phase	7,168	1.6
Brewer very fine sandy loam	9,984	2.2	Riverwash	1,152	.2
Brewer silt loam	1,280	.3			
Brewer silty clay loam	2,112	.5	Total	453,120	
Brewer clay	5,312	1.2			
Verdigris very fine sandy loam	23,360	5.2			
Verdigris silty clay loam	3,520	.8			
Verdigris loamy very fine sand	9,152	2.0			

PRAIRIE SOILS WITH MODERATELY FRIABLE SUBSOILS

In this group are included Bates silt loam, Bates fine sandy loam, Bates silty clay loam, and Bates loam, reddish-subsoil phase. These soils have developed from fairly deeply weathered shales and sandstones, and, in most places, the parent formations lie at a great depth beneath the surface. They occur in some large areas several miles wide, but for the most part they occupy many small bodies of prairie land associated more or less closely with the claypan soils of the prairies. The largest bodies are in the northeastern part of the county in the vicinities of Rentiesville, Checotah, and Onapa, where they comprise much of the high undulating prairie. Numerous small areas are in the valleylike prairie land in other sections.

Natural surface drainage is good, and the subsoils are sufficiently penetrable to allow satisfactory underdrainage, yet heavy enough to hold considerable moisture in reserve for crops.

In uncultivated areas, the native vegetation consists of coarse bunch grasses. Much of the land, however, is used for crops, or has been in the past. Erosion is severe on slopes not protected by growing vegetation, and in places where the land has been poorly managed gully washing and sheet erosion have rendered it of very low productivity. These soils are moderately productive, especially where the inherent fertility has been conserved by careful management, and they are suited to the growing of cotton, corn, and forage crops, such as grain sorghums and sorgo. A small acreage is used for wheat and oats. These soils are suited to truck crops, orchard crops, berries, and grapes, most of which are grown only for local and home use in the small home orchards and gardens. Probably 75 percent of these soils is used for producing cultivated farm crops and hay.

Acre yields of cotton are locally reported to range from one-fourth to one-half bale, corn 15 to 25 bushels, oats 30 to 40 bushels, and

wheat 10 to 15 bushels on the smoother heavier soils. Prairie hay produces from one-half to 1 ton. Commercial fertilizers are not generally used, and crop yields on some farms are very low. It is probable that commercial fertilizers would increase yields considerably. Peaches and apples do fairly well where the orchards are given good care, but late spring frosts often reduce or destroy the peach crop.

Bates silt loam.—Bates silt loam ranks as one of the best upland soils in the county. The 12-inch topsoil consists of dark grayish-brown silt loam or very fine sandy loam, which, when dry, has a much lighter color than when moist. The soil material appears to contain only a small quantity of organic matter and is not calcareous. This layer grades into lighter grayish brown silt loam or very fine sandy loam, which, in turn, passes, at a depth ranging from 15 to 20 inches, into yellow crumbly clay loam or clay, containing some brown and gray spots throughout. A layer of interbedded fine-grained sandstone and shale lies from 3 to 5 feet beneath the surface in places.

The relief is undulating or very gently rolling, and drainage is good. Although erosion has not as yet injuriously affected much of this soil, it is generally understood that terracing and strip cropping would be advantageous in conserving the soil materials and water, and consequently productivity, on some of the more sloping areas. Of the soils in this group, probably Bates silt loam is the most productive, as it is less sloping and, on the whole, has less rapid run-off of water.

Bates fine sandy loam.—Bates fine sandy loam differs from Bates silt loam, not only in its coarser topsoil material, looser structure, and lighter color, but because it occupies somewhat more sloping areas. In places some oak trees have encroached on this soil, but for the most part the land is undulating or gently rolling prairie land having good natural drainage. The topsoil is grayish-brown fine sandy loam ranging from 12 to 18 inches in thickness. It is underlain by yellow crumbly but rather heavy clay containing some brown spots throughout and some gray spots in the lower part of the subsoil.

This soil is rather extensive in the northeastern part of the county, and it occurs in small spots throughout many of the small valley-like prairie areas in all sections. Most of it is in farms, which produce mainly cotton, corn, and feed crops. Crop yields are about the same as on the silt loam.

As the relief is more sloping than that of the silt loam, this soil is subject to greater erosion, and in places where poorly managed, the slopes are badly washed. This is a largely used farming soil which requires good management to preserve its native productiveness. Terracing and strip cropping are advantageous in conserving the soil and water, and organic matter should be maintained to insure good production of crops. The soil dries quickly and warms early in the spring, thereby allowing early seeding in most years.

Bates silty clay loam.—Bates silty clay loam is not altogether like the other Bates soils in character of subsoil material, as this layer is somewhat heavier than the typical Bates subsoil. In fact, in places the subsoil approaches the characteristics of a Parsons subsoil, although it is not a claypan.

This soil occurs in a number of small areas on slopes in the northern part of the county on the prairies where the Bates and Parsons

soils are intermingled, mainly north and northwest of Richardsville. In general, this soil occurs in areas where erosion is active, and much of it appears to have been a sandy soil, from which most of the sandy topsoil has been washed.

The 6- to 10-inch topsoil is grayish-brown silty clay loam or heavy loam, containing more or less small black concretions and small shale fragments. This layer grades into heavy yellow or brownish-yellow moderately crumbly silty clay, and in places the lower part of the subsoil has a decided olive-gray cast.

The relief is sloping, and the soil is subject to erosion. In places where poorly managed, the land is gullied, and in other places, the soil is thin over areas where sheet erosion has caused a loss of topsoil.

Most of this land is in cultivation. Cotton, corn, and feed crops are grown. Cotton yields are fairly good where the land is not severely eroded, but in general the soil is not well suited to corn. Oats, sorgo, and grain sorghums do fairly well.

Bates loam, reddish-subsoil phase.—Bates loam, reddish-subsoil phase, consists of brown or reddish-brown very fine sandy loam to a depth of about 10 inches. This material grades into red or brownish-red heavy loam or very fine sandy loam, which, at a depth ranging from 12 to 16 inches, grades into dull-brown or reddish-brown crumbly clay, in places containing some small fragments of fine-grained sandstone. In cultivated fields the soil has a somewhat red hue.

Although this soil is of small extent, practically all of it is cultivated. It occurs on slopes on the crests of some broad divides. A number of very small areas are in the northern part of the county, associated with areas of other Bates soils. It has about the same adaptation to crops as the associated Bates silt loam, and yields are similar to those obtained on that soil. This has proved to be a very good soil for grapes, orchard fruits, and berries.

PRAIRIE SOILS WITH CLAYPAN SUBSOILS

In this group are included Parsons silt loam, Parsons very fine sandy loam, Parsons very fine sandy loam, deep phase, and Parsons very fine sandy loam, slope phase. These soils occur more or less in association throughout all parts of the prairie land but more particularly in large bodies in the northern part of the county in the vicinities of Checotah, Hitchita, and Richardsville; in the southern part between Eufaula and Stidham; and in several other parts on the high rolling prairies. These soils represent typical claypan soils of the prairies extending from Kansas southward to this and adjoining counties.

These soils are not dark, although they have developed under prairie conditions from parent materials consisting chiefly of shale. The topsoils are grayish brown, the subsurface material is gray, and the dense heavy clay subsoils are known as claypans. These soils normally range from flat to undulating, but in a few places there is a sloping relief, where more or less of the land is badly washed and gullied, although a very large proportion remains smooth and uneroded. Downward drainage is slow, as the dense subsoil is slowly penetrated by water or plant roots. Some of the flat areas have a large number of small sand mounds scattered over the surface. These soils dry slowly and are late warming in the spring.

Although the surface soils differ considerably in thickness and to some extent in relief, the subsoils have the common quality of being exceedingly heavy and resistant to internal drainage and aeration. This has given rise to gray-brown acid topsoils which rest on the stiff subsoil. In most places the subsurface soil overlying the clay subsoil is very light gray. In most areas the parent shale material has weathered deeply and lies several feet beneath the surface.

Inherently these soils are only moderately productive, and under fairly favorable conditions they produce fair yields of cotton, corn, small grains, and sorghums. Oats, Sudan grass, hegari, and soybeans are common crops which succeed in normal seasons. Lespedeza, cowpeas, and soybeans are used successfully for soil improvement. Wet conditions caused by poor underdrainage sometimes cause late planting, and consequently corn is not always well advanced before the usual dry period in summer takes place and injures the crop. Cotton ordinarily withstands the dry season much better than corn, and small grains are generally matured before the hot dry summer season begins. Alfalfa is not well suited to the claypan soils, and grapes and fruits do not thrive so well as on soils with more permeable subsoils. Many vegetables can be grown, but the soils are not considered especially suited to them. These soils remain wet until late in the spring, and when the hot dry summer sets in, they bake and pack very hard. Probably prairie hay, cotton, grain sorghums, and small grains thrive better than most other crops.

Parsons silt loam.—The 12-inch surface layer of Parsons silt loam consists of grayish-brown or dark-gray silt loam which grades into light-gray silt loam containing brown splotches, and this material, in turn, at a depth of about 18 inches, rests on mottled yellow and gray dense waxy clay. In places the color of this clay is yellowish brown or grayish brown. When dry the clay subsoil is exceedingly tough—a true claypan—and is very slowly penetrated by water or plant roots. In places there are small rounded sand mounds over the surface.

The relief is nearly flat or slightly undulating, and drainage is slow. Owing to the unfavorable character of the subsoil, crops are more injuriously affected in wet weather than in dry weather.

Probably 80 percent of this soil is cultivated, and a rather large acreage is used for pasture and for native prairie hay which yields from one-half to 1 ton an acre. From 4 to 8 acres a head are required for summer grazing of livestock. According to local information, acre yields of cotton are about one-fourth bale, corn 10 to 25 bushels, wheat 8 to 25 bushels, and oats 20 to 45 bushels (pl. 1, *B*). Oats are a good crop to grow on this heavy land with a tight subsoil.

Parsons very fine sandy loam.—Parsons very fine sandy loam has essentially the same characteristics as Parsons silt loam. It has smooth very mild relief. The light-brown surface soil extends to a depth of about 12 or 15 inches, the lower part of which is gray. It rests on dense tough grayish-brown clay with yellow spots. Owing to a high percentage of very fine sand, this soil is very susceptible to wind drifting in plowed fields. The claypan subsoil is difficultly penetrable by moisture and plant roots.

The most extensive development of this soil is in the central part of the county between Eufaula and Lenna. It is estimated that about

85 percent of the land is under cultivation, and the rest is used either for pasture or hay. The same general crops are grown, and yields are approximately the same as on Parsons silt loam.

Parsons very fine sandy loam, deep phase.—The deep phase of Parsons very fine sandy loam is gray or grayish-brown very fine sandy loam to a depth of about 10 inches, where it grades into gray very fine sandy loam which, at a depth ranging from 20 to 30 inches, rests on or grades very sharply into mottled yellow, gray, and brown dense clay. Many small rounded sand mounds occur over the surface.

This soil is of small extent. It occurs chiefly in some fair-sized bodies in the vicinities of Stidham and Richardsville.

Probably 80 percent of the land is cultivated. Cotton and corn are the principal crops, but, according to local reports, yields frequently are not quite so high as on the typical soil, owing, perhaps, to very wet conditions in early spring when planting may be delayed by the saturated condition of the very flat land. Small grains (especially oats), sorghums, sweetpotatoes, and peanuts do well. Yields of most crops probably average about the same as on the typical soil. As in that soil the organic matter is deficient. Probably by adequate drainage and by fertilization this soil could be used for growing some truck crops.

Parsons very fine sandy loam, slope phase.—The slope phase of Parsons very fine sandy loam differs from the typical soil chiefly in having a surface slope ranging from 2 to more than 4½ percent. Where the land is poorly managed, erosion has removed the topsoil to such an extent that most of the surface layer is considerably thinner than in the typical soil. On some of the long-cultivated farms large and small gullies have formed in places, rendering cultivation difficult and impractical. In such places the soil is marginal for cultivated crops.

Crop yields are much lower than on the typical soil, not only because some of the surface soil material has been washed away, thereby decreasing the fertility of the soil, but also because of the low penetrability of the soil to water and the droughty character of the thin layer of remaining soil. The soil is especially subject to erosion because of the impenetrable character of the subsoil which absorbs water very slowly. Terracing and strip cropping aid in reducing water losses and in preventing erosion. Probably 70 percent of the land is in cultivation, but much of this is unfit for cultivated crops as a permanent agriculture and should in many places be returned to pasture.

Much of this soil is in the central part of the county between Eufaula and Stidham, and small areas are in other sections. Most of the bodies are associated with the smoother areas of the typical soil.

FORESTED UPLAND SOILS

This group of soils includes Teller fine sandy loam, Teller fine sandy loam, rolling phase, Stidham very fine sandy loam, Stidham fine sand, Stidham loamy fine sand, and Hanceville fine sandy loam. They cover a total area of 140.5 square miles, or 19.8 percent of the land area of the county. The Teller and Stidham soils, which have developed from old alluvial deposits on high benches, occur for the most part in a broken belt several miles wide just north of and

paralleling the Canadian River bottom lands across the southern part of the county. Some areas are on very high benches in the vicinity of Stidham and bordering the valley of North Canadian River. The Hanceville soil, developed from sandstone, is extensive in the eastern part of the county on ridges and slopes below the rough sandstone areas. As a whole, the soils of the group have light sandy topsoils underlain by sandy friable and very permeable subsoils.

The uncleared areas support a forest, principally of oak and hickory trees. A very large proportion of some of these soils is or has been farmed. The soils range from highly to only moderately productive and are suited to a number of crops. They produce good yields in places where the subsoils are sufficiently heavy to hold moisture well. They are rather deficient in organic matter, and results have shown that crops respond well to commercial fertilizers, though practically no fertilizer is used, except for truck crops. All these soils respond well to the incorporation of organic matter and to the growth of legumes, such as cowpeas, which in many fields are planted with corn. The soils are well suited to vegetables, many truck crops, berries, fruits, and grapes, but they are used chiefly for cotton, corn, and feed crops. Where unprotected by growing vegetation, the soils may blow considerably in the strong spring winds.

Teller fine sandy loam.—The 15-inch topsoil of Teller fine sandy loam consists of grayish-brown fine sandy loam or loamy fine sand which contains a rather large proportion of very fine sand. This material changes very gradually to reddish-yellow or reddish-brown fine sandy clay loam which continues to a depth of several feet. The soil is friable and easily worked, absorbs and holds a considerable amount of moisture, and is drought resistant. In places, good well water is reached at a depth of about 25 feet. The relief ranges from nearly flat to gently undulating.

This soil is of very small extent and occupies the flat uneroded remnants of some high old stream terraces. It occurs chiefly in the southwestern part of the county in the vicinity of Hanna.

The original forest growth consisted mainly of red oak, post oak, blackjack oak, and hickory, but little of this growth remains, as practically all the land is in cultivation. The principal farm crops are cotton and feed crops (chiefly corn). The soil is productive, and cotton yields about one-half bale an acre in good seasons, if damage from insect pests is not too severe. Yields of corn range from 25 to 40 bushels an acre, depending largely on moisture conditions. Grain sorghums and sorgo grow well and return good yields.

In recent years a rather large acreage has been planted to potatoes and onions. It is estimated that on this and adjoining soils, in the section around Hanna, about 1,000 acres are in onions and 500 acres in potatoes. According to local information, onions yield 200 or more bushels an acre. Two crops of potatoes are grown in the same year. One matures in July and produces about 100 bushels an acre, and the second crop is harvested during the early part of November and produces about 50 bushels an acre. Very little of the land is devoted to truck crops. Truck crops are fertilized with commercial fertilizers of a 4–8–4 analysis, at the rate of about 200 pounds an acre.

This is an excellent soil for various truck crops, fruits, and berries, and it is considered about the best upland soil in the southwestern part of the county.

Teller fine sandy loam, rolling phase.—The topsoil of Teller fine sandy loam, rolling phase, is grayish-brown fine sandy loam or loamy fine sand, ranging from 10 to 15 inches in thickness. In places the color is somewhat red. This material grades into light-red, yellowish-red, or reddish-yellow fine sandy clay. On some slopes much of the surface soil has been washed away, leaving only a thin layer of topsoil, and in other places the displaced and removed topsoil of higher lying slopes has accumulated to a depth of 2 feet or more on the lower slopes.

This soil is much like typical Teller fine sandy loam in general characteristics, but in many places it has been subjected to the modifying influences of erosion. The relief ranges from gently to strongly rolling, and many gullies have cut deeply, dissecting most of the areas.

Most of the original forest growth of oak and hickory has been removed. Nearly all the cleared land has, at some time, been cultivated, but at present much of it has been withdrawn from cultivation. Crop yields are moderate where spots of fairly smooth soil remain, but in general they are low. The principal crops are cotton, corn, and other feed crops, and yields range from very small to perhaps half as much as those on the typical soil.

No attempt is made to terrace this land and prevent erosion; in fact, much of it is too steep to warrant the expense of terracing. Much of the land would be better suited to soil-improving and soil-holding pasture and feed crops than to row crops, such as cotton, which require clean cultivation and afford little protection from erosion. The less sloping areas might be carefully farmed by strip cropping and by growing crops requiring no cultivation.

On many of the more steeply sloping farms, this rolling soil is probably less than one-fourth as valuable as the typical soil. Soil of this phase occupies a rather large acreage.

Stidham very fine sandy loam.—The 15-inch surface layer of Stidham very fine sandy loam is grayish-brown or brown very fine sandy loam or loamy very fine sand. This material grades into yellowish-brown very fine sandy loam which gradually becomes heavier with increase in depth, and, at a depth ranging from 20 to 30 inches, the material is yellow or yellowish-brown fine sandy clay loam containing some spots and splotches of brown and a few black concretions. Below a depth of about 50 inches the material has some gray mottlings or splotches in places. In places the subsoil, to a depth of more than 3 feet, is no heavier than fine sandy loam.

The relief, in general, is nearly flat or slightly undulating, and drainage is good, owing to the permeable character of the subsoil.

This soil occurs in several good-sized areas on the old terraces, in association with the Teller soils, and on a high flat just north of Stidham, where it probably constitutes a very high ancient terrace of alluvium.

Practically all the land is in cultivation, and the principal crops are cotton, corn, grain sorghums, and sorgo, yields of which are very

good—approximately the same as those on Teller fine sandy loam. Some truck crops are grown, mainly potatoes, and onions, which produce yields similar to those on the Teller soils. Unprotected areas of this soil are subject to drifting in the strong spring winds. Although in most areas the land is so nearly flat that erosion is not serious, farm practices must be such as to prevent the formation of gullies, and terracing would be advantageous in some places for the conservation of both water and soil. Growing legumes and adding organic matter conserve the productiveness of this soil. The soil is suited to fruits, berries, and various truck crops, but only small acreages are used for these crops.

Stidham fine sand.—In virgin areas the surface layer of Stidham fine sand is gray or grayish-brown fine sand about 4 inches thick, and it is 8 or 10 inches thick in cultivated fields. This material grades into pale-yellow or pale yellowish-gray fine sand which continues to a depth of several feet. In places yellow fine sandy clay, splotched with gray, lies from 2 to 3 feet beneath the surface.

This soil occurs in a number of smoothly undulating areas on the old terraces lying high above overflow, chiefly along the valley of Canadian River in the southern part of the county. It is closely associated with the Teller soils, but in most places occupies somewhat higher elevations. This soil has good drainage chiefly because of the permeable subsoil, and erosion is not serious, but the unprotected soil may drift during periods of strong spring winds and thus retard the growth of young plants.

The forest growth is chiefly post oak, blackjack oak, and hickory. Probably less than one-fourth of the land is in cultivation. This is a loose thin soil which leaches readily, is deficient in organic matter, and is not highly productive. It is more especially suited to such crops as watermelons, peanuts, peas, berries, and small fruits. Cotton and corn are the chief crops grown, however, and some of the land is devoted to the other crops mentioned. Cotton probably averages less than one-fourth bale an acre, depending on the condition of the soil, and corn yields also are low. This soil responds well to commercial fertilizers, but they are not in general use. The productiveness can be increased to some extent by growing legumes and by adding organic matter. The soil is too light in texture for growing the ordinary farm crops, as yields of cotton and corn are scarcely high enough to be profitable.

Stidham loamy fine sand.—The 10-inch topsoil of Stidham loamy fine sand is light-brown or grayish-brown loamy fine sand. It grades into yellow fine sand which continues to a depth of several feet. In some places, yellow fine sandy loam occurs in the subsoil at a depth ranging from 2 to 3 feet. Ordinarily this soil is slightly darker and more loamy than Stidham fine sand. Apparently it contains more organic matter and is somewhat more productive than that soil.

Stidham loamy fine sand occurs in a number of small areas on the old terraces bordering the valley of Canadian River in the southern part of the county, and a few small areas are on the high terraces above overflow in other large stream valleys. The more general occurrence of the soil is on the lower terraces on which the Brewer soils predominate, rather than on the higher terraces occupied by the Teller and other Stidham soils. The relief is smooth, and drainage is good, owing to the very permeable sandy subsoil and substratum.

Most of the land has been cleared of the native forest growth of oak and hickory, and it is used mainly for growing cotton and corn. Some is used for grain sorghums, and small acreages are devoted to sweetpotatoes, potatoes, peanuts, melons, peas, and various incidental crops grown in conjunction with the cotton and feed crops. The soil has about the same crop adaptations as Stidham fine sand, but yields are slightly higher. This is a good soil for growing truck crops, as it is well suited to berries, grapes, and orchard fruits and especially well suited to melons and peanuts. The unprotected soil is subject to drifting in strong spring winds, thereby causing injury to or loss of young crops, but the likelihood of injury is less than on the lighter textured Stidham fine sand. The soil responds well to applications of manure and organic matter and probably would give a good response to commercial fertilizers. At the time this survey was made, some apple and other fruit trees were growing well on this soil.

Hanceville fine sandy loam.—The topsoil of Hanceville fine sandy loam is grayish-brown loamy fine sand which, on becoming thoroughly dry, is light gray. This layer is about 4 inches thick in virgin areas, and in cultivated areas it is 8 or 10 inches thick. It grades into yellow or reddish-yellow heavy fine sandy loam or loamy fine sand, which, at a depth ranging from 15 to 20 inches, grades into reddish-yellow or red fine sandy clay loam. This material, at a depth ranging from 2 to 4 feet, grades into disintegrated and partly weathered sandstone. In places the broken sandstone parent material lies within 10 inches of the surface. Such areas constitute a shallow phase which was not separated from the typical soil in mapping, owing to its very irregular occurrence. On a few slopes, where erosion has been unusually active, the topsoil has a somewhat red hue.

Hanceville fine sandy loam is an extensive soil and occurs in many parts of the county on ridges and slopes, in places lying adjacent to Hanceville stony loam and rough sandstone land. The largest areas are in the eastern part of the county, and some good-sized bodies are scattered throughout the western part.

This soil has developed from sandstone beneath a forest growth, chiefly of post oak, blackjack oak, and hickory. The soil is loose and contains little organic matter. Steeply sloping areas are subject to erosion where unprotected, as evidenced by deep gullies and gully heads centering in shallow spots on some slopes. Where farmed, the smoother areas of this land should be terraced, and the more steeply sloping areas should be allowed to remain in pasture or woodland.

This soil is not highly productive, even in the smoothest areas where the soil mantle is thick and the sandstone parent material lies at considerable depth. The principal crops are cotton and corn. Some feed crops, such as grain sorghums and sorgo, also are grown. Some small orchards of fruits—peaches, plums, and apples—indicate that on the areas of deeper soil, well-cared-for fruit crops are successful. Vegetables, peanuts, melons, sweetpotatoes, and several other truck crops do well. The areas of shallower soil are rather droughty, and crops do not yield well in dry seasons; in fact, in the very shallow places, high yields are not possible. Cotton yields one-fourth or

one-fifth bale on the better areas of deep soil, and corn yields are, in general, low.

This soil responds well to applications of manure, organic matter, and commercial fertilizers, and growing cowpeas improves the soil considerably, especially if the vines are plowed under. Where carefully managed, this soil affords a good opportunity for the successful production of fruit and truck crops.

DARK-COLORED SOILS OF THE SECOND BOTTOMS, OR TERRACES

This group consists of Brewer very fine sandy loam, Brewer silt loam, Brewer silty clay loam, and Brewer clay. These soils are the most desirable and, probably, on the whole, the most productive soils in the county. In actual productiveness some of the alluvial soils produce higher yields, but, because of the slighter injury from insect pests and from overflow, the Brewer soils are more generally dependable than the first-bottom alluvial soils.

These dark soils of the terraces have developed from old alluvial deposits on high terraces long free from overflow, which lie from 15 to 30 feet above the present flood plain. The deposits comprise dark soil materials washed largely from the prairies and plains to the west, and probably the soils have developed under a heavy growth of grass, although, in places, some oak, ash, hackberry, pecan, and elm trees grow. The soil materials, apparently, were originally calcareous or were developed from calcareous formations, as in a few places some of the soils have calcareous material in the subsoil.

The surface soils are dark, nearly black in places, and they have good structural qualities, in that they crumble readily under cultivation. The subsoils are brown or yellowish brown and, though fairly heavy, are not dense or difficultly penetrable to water.

These soils are highly productive and, though not very extensive, occupy some important bodies of smooth nearly flat land bordering the flood plains of Canadian River and North Canadian River, and smaller areas are along some of the other streams. Some of the principal bodies lie within a few miles of Eufaula. Most of the land is in cultivation, and the chief crops are cotton, corn, and grain sorghums.

Brewer very fine sandy loam.—Brewer very fine sandy loam is probably the most valuable soil of this group because its textural character affords a wide range of crop suitability, and this, added to ease of cultivation and high productiveness, gives a very high all-round value.

The topsoil is dark-brown or nearly black very fine sandy loam about 10 inches thick. It grades into somewhat heavier and darker brown very fine sandy loam or clay loam. In places layers of brown light fine sandy loam or very fine sandy loam occur in the lower part of the subsoil. In places the topsoil is fine sandy loam or loamy fine sand, but on the map no separation is made of the more sandy areas.

Most of this soil is in cultivation, and cotton and corn are the chief crops. Cotton yields from one-half to 1 bale an acre, and the average yield is probably not more than three-fourths bale in good seasons, owing to insect pests which affect cotton, causing consider-

able loss during some years. Corn yields from 25 to 60 bushels an acre. The lower yields are caused by insufficient rainfall in some seasons. Alfalfa yields from 3 to 5 tons, and grain sorghums, oats, and various other crops, grown on very small acreages, produce good yields. Truck crops do well, but they are grown only in small gardens for local and home use.

Brewer silt loam.—The topsoil of Brewer silt loam consists of very dark brown or nearly black silt loam about 15 inches thick, which in a few places contains a rather large quantity of very fine sand. This material in places passes gradually into gray or grayish-brown clay loam or clay at a depth of about 2 feet. In places a layer of yellowish-brown heavy loam or very fine sandy loam occurs at a depth of 2½ or 3 feet.

This soil is of small extent. It occurs in a number of small bodies on the benches bordering the flood plains of Canadian and North Canadian Rivers.

Most of the land is used for growing cotton and corn, and yields are approximately the same as those obtained on Brewer very fine sandy loam.

Brewer silty clay loam.—The topsoil of Brewer silty clay loam is dark grayish-brown or grayish-black silty clay loam ranging from 10 to 15 inches in thickness. It grades into dark-gray or nearly black silty clay or clay loam. In places a fine sandy clay loam layer occurs below a depth of 30 inches, and in some places the material contains concretions of calcium carbonate at a depth of 3½ or 4 feet.

A number of small areas of this soil occur on the high smooth terraces bordering some of the larger streams, in association with other soils of the Brewer series.

Cotton, corn, and feed crops are commonly grown, and, as the land is highly productive, yields are about as high as on Brewer very fine sandy loam; in fact, they are probably somewhat higher for most crops. This soil is more difficult to cultivate than Brewer very fine sandy loam and is not so well suited to truck crops and fruit.

Brewer clay.—The 10- to 15-inch topsoil of Brewer clay is grayish-black or very dark gray heavy dense clay which, on drying, breaks apart naturally into fine clods and irregular coarse grains. The material grades into brown waxy heavy clay which extends to a depth of several feet, and in places it is calcareous and contains fine concretions of calcium carbonate and some fine crystals of calcium sulphate.

The land is nearly flat, but in most places surface drainage is adequate for good crop growth. In some places, however, the land is so flat that during wet seasons planting and the growth of crops are greatly delayed, and grass and weeds become well established before cultivation is possible. Most of the land is in cultivation, mainly to cotton and corn. Cotton yields as high as one-half or three-fourths bale an acre and corn from 30 to 40 bushels in favorable situations. This soil is difficult to cultivate, but it is strong and highly productive. It produces good yields of grain sorghums, sorgo, and alfalfa, but not a great deal of the land is sown to alfalfa.

This is not an extensive soil. It occurs in small bodies on the terraces in association with other Brewer soils. A few steep slopes consisting of brown heavy calcareous clay are eroded to considerable

extent and consequently are less productive than the typical soil. Some such areas are not cultivable.

WELL-DRAINED ALLUVIAL SOILS

The soils of this group are Verdigris very fine sandy loam; Verdigris very fine sandy loam, colluvial phase; Verdigris silty clay loam; Verdigris loamy very fine sand; Verdigris very fine sand; Yahola very fine sandy loam; and Lincoln fine sand. They occur in the flood plains of Canadian and North Canadian Rivers, Deep Fork, and the other streams of the county. For the most part, they are friable and have good surface drainage and underdrainage, so that, although occasionally overflowed, drainage is adequate to allow the successful cultivation of crops.

Most of these soils are cultivated and devoted to the production of cotton, corn, and feed crops, such as grain sorghums and sorgo, together with small acreages in various other crops, including alfalfa.

These soils are developed from materials washed from the uplands and brought down from the drainage area of the individual stream and deposited during overflows. Along Canadian River some soils of somewhat red or chocolate color indicate the presence of "Red Beds" materials of the western prairies and plains, and these soils are fairly calcareous. The soils of the other stream bottoms are brown and are derived from noncalcareous materials of the eastern part of the State. The reddish-brown soils are included in the Yahola series, the brown soils in the Verdigris series, and the light-brown or gray calcareous soils in the Lincoln series. All the well-drained alluvial soils are fairly productive and generally return good yields, but some have such sandy subsoils that yields are light. On some of the better soils, cotton grows so rank that losses are incurred by excessive injury from insects.

The soils, which originally supported a rather heavy forest growth of oak, sycamore, elm, ash, pecan, locust, hickory, birch, and other trees, have been almost entirely cleared and placed in cultivation.

Verdigris very fine sandy loam.—The topsoil of Verdigris very fine sandy loam is brown or grayish-brown very fine sandy loam to a depth ranging from 12 to 18 inches. It grades into dark-brown heavy very fine sandy loam or clay loam. In many places layers of sandy materials of fine sandy loam or very fine sandy loam texture lie at a depth ranging from 2 to 5 feet beneath the surface.

This soil occurs in many small and narrow areas in the first bottoms of North Canadian River and Deep Fork, also along many creeks. About 95 percent of the land is cultivated. It is overflowed occasionally but, for the most part, is successfully cultivated to cotton, corn, and feed crops, such as sorghums. The overflow waters usually recede rapidly, and crops generally yield well. Cotton produces from one-fourth to three-fourths bale an acre, sometimes more, although much loss is often sustained through injury done by insects. Corn yields from 30 to 60 bushels an acre. Sorghums, oats, alfalfa, and many other crops, grown to a small extent, produce excellent yields. Pecan trees make a good growth, and many fine native trees are left in the cleared fields and produce good yields of nuts. Orchards of the improved paper-shelled varieties of pecans are grown successfully.

Verdigris silty clay loam.—The 10-inch surface layer of Verdigris silty clay loam is brown silty clay loam. It is underlain by dark-gray or brown silty clay which extends to a depth of several feet. In many places, it is underlain by sandy layers at a depth of a few feet beneath the surface.

This soil occupies a narrow almost continuous strip of bottom land along Deep Fork. It has fairly good surface drainage, although it is overflowed occasionally. Probably one-half of the land is cultivated, and the rest supports a forest growth consisting chiefly of bur oak, spotted oak, black oak, elm, and pecan. This is a good strong highly productive soil. It produces from 20 to 40 bushels of corn and from one-fourth to one-half bale of cotton an acre. Sorghums and other forage crops yield well. Alfalfa probably will do well in the better drained situations. Native pecan trees are proportionately more numerous on this soil than on Verdigris very fine sandy loam.

Verdigris loamy very fine sand.—The topsoil of Verdigris loamy very fine sand is brown or grayish-brown loamy very fine sand or very fine sandy loam, which grades, at a depth ranging from 12 to 18 inches, into yellow or grayish-yellow very fine sand continuing to a depth of several feet. This soil is not calcareous, but it is not strongly acid in reaction. In textural characteristics it is similar to Yahola very fine sandy loam, but it does not have the reddish-brown color common to the Yahola soils. It is composed mostly of very fine sandy materials washed from the nearby humid Prairie soils region.

This soil occurs chiefly along North Canadian River. The land is largely cleared of the tree growth, and most of it is in cultivation to cotton, corn, and various feed crops, such as sorghums and sorgo. In places where the subsoil is very light textured, yields are moderate. Probably from one-fourth to one-half bale of cotton and from 20 to 40 bushels of corn an acre are produced.

This soil is very variable. Spots of Verdigris very fine sandy loam occur throughout areas of the loamy very fine sand, and, in such places, owing to the heavier subsoil and deeper layers containing organic material, crop yields are much higher.

Verdigris very fine sand.—The topsoil of Verdigris very fine sand is brown or grayish-brown loose very fine sand which grades, at a depth ranging from 12 to 15 inches, into light-brown or brownish-yellow loose very fine sand. The soil material is very slightly loamy. The total area of this soil is not extensive.

This soil occurs chiefly along North Canadian River and is for the most part a very loose soil of the bottom land adjacent to the stream. Most of the land is cultivated, mainly to cotton, corn, and feed crops. The soil is not highly productive. Yields of cotton and corn probably average about one-half as much as on Verdigris loamy very fine sand. This soil is suited to sorghums, melons, sweetpotatoes, beans, peas, and various vegetables, but not much of the land is devoted to these crops.

In places the surface is so uneven as to make the land difficult to cultivate, and the soil is less uniform than are the other bottom-land soils. This soil is not calcareous. Where not cultivated the land supports a growth of large hackberry, elm, ash, bur oak, pecan, sycamore, and cottonwood trees. In spots the topsoil is very silty, owing

to deposits from recent overflows. This is a considerably lighter and thinner soil than the more extensive Verdigris loamy very fine sand.

Verdigris very fine sandy loam, colluvial phase.—The topsoil of Verdigris very fine sandy loam, colluvial phase, consists of brown fine sandy loam or very fine sandy loam, which, on drying, becomes gray or grayish brown. This layer extends to a depth ranging from less than 1 foot to more than 3 feet with little change in color or texture. In places it contains much fine sand, and in other places it consists largely of very fine sand and silt. This soil varies considerably in texture, in both the topsoil and subsoil. In many places it consists of an accumulation of sandy material at the foot of slopes, which has been deposited by run-off surface water carrying eroded soil materials from the adjacent slopes. The soil in fact has no uniformity of material but is simply eroded soil material from adjoining slopes and is occasionally overflowed by run-off water from these slopes. It is for the most part fairly productive and is farmed as a part of fields consisting chiefly of other soils. It produces fairly good yields of cotton, corn, and sorghums.

Yahola very fine sandy loam.—Yahola very fine sandy loam consists of reddish-brown very fine sandy loam or heavy loamy very fine sand to a depth ranging from 15 to 20 inches. This material grades below into chocolate-brown or reddish-brown heavy very fine sandy loam which, in turn, below a depth ranging from 26 to 30 inches, grades into reddish-yellow or yellow very fine sand. Although the topsoil is fairly uniform, the texture of the subsoil varies greatly from place to place, but, as a rule, it contains very light layers of sandy material, some of which are lighter in texture than the topsoil. The areas are, in most places, calcareous throughout.

This soil occurs in a number of areas in the bottom land of Canadian River. One of the largest is a few miles south of Eufaula. The relief is nearly flat, though it may be slightly undulating and bumpy or irregular in places. Surface drainage and underdrainage are good, and the land is very seldom overflowed, as it is a high bottom.

Most of this soil has been in cultivation for many years and is considered a valuable agricultural soil. Cotton and corn are the chief crops. This soil ranks about as high as Verdigris very fine sandy loam in the production of these crops, but, probably owing to the somewhat lighter textured subsoil, it is not everywhere quite so productive as that soil. Corn yields from 20 to 40 bushels, and cotton from one-fourth to one-half bale an acre. The soil is well suited to alfalfa and sorghums, but only small acreages of these crops are grown. It is an excellent soil for vegetables and various other truck crops, small fruits, pecans, peaches, berries, and grapes. Practically all the land is in cultivation.

During the course of the survey, it was noted that crops on this soil showed a close relationship to the subsoil conditions. In places where there is a clay loam layer in the subsoil, cotton and corn seem very highly successful, and, judging from appearances, spots with a heavy subsoil layer at a depth ranging from 18 to 24 inches will yield twice as much cotton and corn as areas in which the subsoil consists entirely of light very fine sand. Some areas of the better soil are reported to yield from three-fourths to 1 bale of cotton an acre in favorable seasons.

Lincoln fine sand.—The topsoil of Lincoln fine sand consists of gray or very light grayish-brown loose fine sand which, in places, has a rather large content of very fine sand and an appreciable content of silt. The material in this layer grades into yellow or grayish-yellow very loose fine sand which continues to a depth of several feet. As a rule, the soil is calcareous throughout.

This soil is of small total area, but it occurs in a number of strips in the bottoms of Canadian River. It occupies smooth low ridges rising slightly higher than the surrounding soils and has good drainage. The land is overflowed occasionally and, where unprotected, may be shifted during some overflows or by heavy winds onto heavier soils, thereby rendering less valuable some of the better soils of the bottom land.

This is a loose light soil which is not very productive, but much of it is cleared and farmed. Cotton, corn, and feed crops do not produce high yields, probably not more than one-fourth as large as those obtained on Yahola very fine sandy loam, with which this soil is associated. It seems suited to plums, as these grow wild in places, and to watermelons, peas, peanuts, and sorgo, though yields of these crops are small, as the soil consists of little else than fine quartz sand. It could be made somewhat more productive by the application of organic matter and by growing peas or beans.

IMPERFECTLY DRAINED ALLUVIAL SOILS

The soils of this group are Perry silty clay; Perry silty clay, better drained phase; Lightning silty clay loam; Lincoln very fine sandy loam, poorly drained phase; Yahola silty clay loam, depression phase; and Verdigris soils, undifferentiated, depression phase.

These soils differ greatly in general character and in inherent fertility, but all have one feature in common; that is, they have such poor drainage that they are not used to an important extent for crops. They occur in low bottoms, and, although they are dry during most of the summer, they occasionally are covered with water or are saturated until late in the growing season. Although they support some water-loving trees, they are not definitely swampy in large areas. A forest growth of bur oak, elm, spotted oak, ash, pecan, and other trees remains on the heavier soils, and sycamore, willow, and cottonwood trees grow on the sandy soils.

Perry silty clay.—The 10-inch surface layer of Perry silty clay is brown or grayish-brown silty clay. It is underlain by mottled brown and gray silty clay containing some yellow spots. In places the subsoil, below a depth ranging from 18 to 24 inches, is mottled or splotched with rust brown and contains some semihard black concretions. This soil is not calcareous and is more or less acid in reaction. The lower part of the subsoil, however, at a depth ranging from 3 to 5 feet, is generally calcareous.

The relief is flat, and water stands for some time after inundations which occur several times a year. Most of the land supports an open forest growth of spotted oak, bur oak, water oak, ash, hackberry, elm, sycamore, honeylocust, and pecan trees.

This is the most extensive soil of the group, and it occurs mainly in the western part of the county in the bottom lands of Deep Fork. The land is fairly productive, and, if protection from overflows and adequate drainage were provided, it would produce good yields of

cotton, corn, and various feed crops, such as the sorghums and Sudan grass. In its present state of cultivation, yields are more or less uncertain.

Perry silty clay, better drained phase.—Perry silty clay, better drained phase, differs from the typical soil chiefly in that it has a darker topsoil, a reddish-brown upper subsoil layer, and a grayish-brown lower subsoil layer. This soil lies at a slightly higher elevation than the typical soil, and the land drains more rapidly, but it is subject to overflows that cover the surface deeply. Therefore most of the land is not well suited to farming. There is only a small total area of this soil. Several small bodies lie along Deep Fork a few miles southeast of Richardsville in the north-central part of the county. Some of the land is used for growing cotton, and when drainage conditions are favorable, good yields are obtained.

Lightning silty clay loam.—To a depth of 10 inches, Lightning silty clay loam consists of black or very dark brown silty clay loam. It grades into black or dark-brown clay containing some gray spots or mottlings at a depth ranging from 2 to 3 feet.

This soil is not extensive. It occurs in a number of small areas along Mill Creek in the southwestern part of the county and along Deep Fork in the northwestern part.

Lightning silty clay loam is somewhat similar to the Perry soils. It is not so severely overflowed, therefore is not wet so much of the time as the Perry soils. Less than half the land is cultivated, mainly to corn, sorghums, and cotton, and yields are lower than those produced on the Verdigris and Yahola soils. Much of the land supports a forest growth similar to that on Perry silty clay.

Lincoln very fine sandy loam, poorly drained phase.—To a depth ranging from 12 to 18 inches, Lincoln very fine sandy loam, poorly drained phase, consists of dark-gray or grayish-brown very fine sandy loam. This is underlain by gray or grayish-yellow fine sand or very fine sand, which continues to a depth of many feet. The soil is very variable in the texture, thickness, and regularity of the soil layers. It is a low alluvial bottom-land soil occupying old stream channels which lie below the general level of the surrounding bottom land. In places it is adjacent to the upland slopes and receives local sediments of various kinds of sandy material from the run-off waters of those slopes, but in most places it consists of sediments deposited during overflows of Canadian River. Both the surface soil and subsoil are characteristically calcareous. Sedimentation has produced the irregular layers of sandy and silty material, which, however, are underlain, at a depth ranging from 1 to 3 feet, by light fine sand or very fine sand.

This soil occurs in narrow strips in low spots and depressions, and it is saturated with water most of the time. It supports a tree growth, chiefly of willow, sycamore, and cottonwood. In spots where the land is less wet, it supports a luxuriant growth of grasses, including Bermuda grass. Probably the production of pasture grasses is the best use to which this soil can be put, as it seems entirely unsuited to cultivated crops. No attempt is made to grow crops. Seepage from adjacent higher soils keeps the land wet, but probably ditches would provide sufficient drainage to allow the soil to produce good grass.

Yahola silty clay loam, depression phase.—The topsoil of the depression phase of Yahola silty clay loam consists of chocolate-brown or reddish chocolate-brown silty clay loam ranging in thickness from 10 to 20 inches, in places slightly more. It is abruptly underlain by light-brown, chocolate-brown, or yellow very fine sandy loam or very fine sand. Both the surface soil and subsoil are calcareous, as the soil materials are derived largely from the western plains and "Red Beds" formations, having been deposited by overflow waters of Canadian River.

This soil occupies narrow areas of old stream channels and sloughs where the least rapidly flowing overflow waters deposit the finest sediments of clay and silt. In places there are small spots of clay, and in other places silt loam and very fine sandy loam occupy very small parts of these narrow areas, but the silty clay loam texture predominates.

Much of the land is cleared, and some is cultivated, but the slow drainage is a drawback to the best use of the soil, and for this reason no crops are grown during some seasons. With favorable moisture conditions and drainage this soil yields well—probably under best conditions producing higher yields of cotton, corn, and sorghums than the associated Yahola very fine sandy loam. This is not a dependable soil, however, and it is of such slight extent that it is not agriculturally important. In places native pecan trees make an excellent growth, and some which produce good yields of nuts were left standing when the land was cleared.

Verdigris soils, undifferentiated, depression phase.—Undifferentiated Verdigris soils, depression phase, occupy narrow depressions in the bottom lands of North Canadian River. These areas, for the most part, are old channels of the river and lake beds. Most of the areas range from 100 to 400 feet in width, and some are as much as one-half mile long. The soils consist of an intricate mixture of small spots of Verdigris silty clay loam, Verdigris clay, and Verdigris very fine sandy loam.

In most places the topsoils range from 8 to 15 inches in thickness. They are underlain by gray or yellow very fine sand or very fine sandy loam. In some places the topsoils are more than 2 feet thick over the light-textured subsoils. These soils are not calcareous, and they do not have the red color of the Yahola soils.

These soils are cultivated in places and produce fairly good crops of cotton, corn, and grain sorghums, when the rainfall is not too heavy and the land is not too wet. Owing to their very small extent, these soils are not important in the agriculture of the county. The trees of the original forest consisted chiefly of hackberry, bur oak, spotted oak, elm, sycamore, and pecan. Some areas have been left in native pecan trees which grow well.

MISCELLANEOUS SOILS AND LAND TYPES

This group includes Hanceville stony loam, Talihina clay loam, Talihina stony clay loam, Parsons very fine sandy loam, eroded phase, and riverwash. These soils and land types are, for the most part, nonarable and entirely unsuited to the production of farm crops. Hanceville stony loam includes large areas of land with soil

that is too shallow, stony, and, in places, too steep to allow cultivation. Parsons very fine sandy loam, eroded phase, likewise, is too rough and broken for cultivation, even if the soil were productive. The Talihina soils, though in places cultivable, are so shallow and so low in fertility that their use for farm crops cannot be recommended. Riverwash constitutes loose fine sand subject to frequent inundation and shifting by wind and water.

Hanceville stony loam.—Hanceville stony loam occupies the sandstone hills and ridges which constitute a very large proportion of the land area of the county. The rough-land ridges, where precipitous and very stony, are locally termed mountains, as they rise to a height of several hundred feet above the surrounding country.

Much of the area occupied by the Hanceville soil consists of steep ridges and hills strewn with large rock fragments and boulders, with massive outcropping layers of sandstone. Therefore, large areas are rough stony land. The soil material is light grayish-brown or gray fine sand several inches thick overlying yellow or reddish-yellow fine sand which, at a depth of a few inches, grades into partly weathered sandstone. This soil occupies the less steep slopes and low ridges and the lower slopes of steep ridges, but it is sufficiently stony and shallow to preclude cultivation.

On the less rough areas, the soil material is grayish-brown fine sandy loam or loamy fine sand, several inches thick, grading into yellow or reddish-yellow loamy fine sand or fine sandy loam, and this, in turn, at a depth of a few inches, into broken disintegrated sandstone material. The surface is covered with small rock fragments, and in many places these make up the greater part of the soil mass. In places the subsoil, at a depth ranging from 8 to 12 inches, is red or reddish-yellow crumbly clay.

This land is forested with small or moderately large trees, chiefly post oak, blackjack oak, and hickory. Large areas are in the eastern and western parts of the county, and a number of small smoothly rounded hills and ridges are isolated from the larger areas.

This land has little or no value for cultivated crops, and very little of it is used for any purpose other than grazing, for which it is not very valuable, as the coarse-grass cover is scant in the forest. In places where the land is cleared, however, the coarse bunch grasses make a rather thick heavy growth. The less stony and smooth spots, if cleared, would probably produce fairly good yields of apples, peaches, and grapes. The soil is thin and not highly productive, and its use for farm crops or for any crop except trees or grass is not advisable.

Talihina clay loam.—The topsoil of Talihina clay loam consists of brown clay loam to a depth of several inches. This material grades below into yellowish-brown, reddish-brown, or olive-green silty clay or silty clay loam, containing fine slick particles of shale which give the fine earth a smooth greasy feel. The subsoil, at a depth ranging from 2 to 5 feet, grades into a bed of shale. The soil is variable in color, thickness, and other characteristics and, on the whole, is a shallow poorly developed soil over shale.

This soil occupies high rolling areas and ridges with some fairly steep slopes. It is of small extent and occurs in only a few small

areas well scattered over the prairie section of the county. It supports a scattered growth of persimmon trees, low bushes, and coarse grasses. Small patches in cultivation, in fields consisting mostly of other soils, indicate this soil has little value for producing cotton, corn, and sorghums, or, in fact, any crop. The land is subject to erosion. Gullies form rapidly, and sheet erosion is active where the soil is exposed.

Talihina stony clay loam.—Talihina stony clay loam is brown loam or clay loam to a depth of several inches. It grades into brownish-yellow, grayish-brown, or olive-green shaly crumbly clay, in places mottled with gray, and this material, in turn, at a depth of 1½ or 2 feet, grades into a bed of disintegrated shale. The surface is more or less stony with fragments of hard fine-grained sandstone, some shale, and in places some flat concretions of iron sandstone.

This soil occurs in a number of small areas distributed over the county, in most places adjoining areas of the Hanceville soils. The largest bodies are in the southwestern part west of Vivian and north of Hanna. The relief is rolling, and the land is subject to exhaustive erosion where unprotected by growing plants. This is a shallow stony shale soil which has little or no value for cultivated crops. A few oak trees grow on the rougher sloping areas where sandstone is abundant on the surface. Most of the land is open grassland accompanied by a scrubby growth, mainly of persimmon trees and haw shrubs.

This soil is used only for pasture, and probably this is its best use. According to local authorities, from 6 to 10 acres a head are required for grazing cattle.

Parsons very fine sandy loam, eroded phase.—Parsons very fine sandy loam, eroded phase, consists chiefly of narrow strips of eroded land along gullies extending back into areas of Parsons very fine sandy loam and in places into bodies of other soils.

The brown very fine sandy loam topsoil ranges in thickness from a mere film to as much as 6 inches. It overlies a claypan which is exposed at the surface in many places. Here and there are some small sand mounds which have not been entirely eroded. The exposed yellow or gray dense subsoil shows a white coating in places, indicating the presence of some salts. Steep-walled gullies several feet deep extend back through areas of this land, and they afford rapid passage of run-off water which is rapidly eroding areas of deeper soils.

This soil supports little grass and has no value for cultivated crops. It should be occupied by some soil-saving vegetation, if possible, in order to prevent extension of the eroded land. The land is simply a miniature form of rough broken land.

Riverwash.—The term riverwash is applied to low sand flats and sand bars in the bed and along the banks of Canadian River. The material is gray loose quartz sand or fine quartz sand, which supports little or no vegetation. The land is subject to frequent inundation, shifting, and change by water currents and by wind. It has no agricultural value.

RECOMMENDATIONS FOR THE MANAGEMENT OF THE SOILS OF McINTOSH COUNTY[2]

Methods which can be used to maintain or improve the fertility of the soil have received very little consideration by many of the farmers in this county. Landowners have been interested in the maximum income that can be derived by using an extensive type of agriculture, and tenants on many farms have been required to plant crops which yield a maximum acre return at harvest time. A few farmers have been following a livestock system of farming, but most of the cultivated land is used for the production of cash crops, such as corn and cotton. The drain on soil fertility is generally greater under a system in which the sale of grain or cotton is the chief source of income than under a system in which livestock and livestock products are sold. As the production of forage is more certain than the production of grain and cotton, because of unfavorable climatic conditions and other factors which may interfere with plant development before the crop is mature, one of the important problems in farm management is to determine whether farmers can change their system of farming from grain and cotton to a livestock system which will maintain and improve the productivity of the soil with a minimum investment for plant nutrients.

McIntosh County is in a humid section, and a large proportion of the soils are comparatively low in potential crop-producing capacity, owing to the small amounts of plant nutrients present in the rocks from which the soils have developed and to the leaching effect of rainfall. The native vegetation on much of the land was little bluestem (*Andropogon scoparius*), also called prairie beardgrass, and other prairie grasses, and the organic-matter content of many of the virgin soils was comparatively high. As a result of cultivation this condition has changed, and a marked decrease has taken place in the content of nitrogen and organic matter in the soils. Chemical analyses, made on samples of soil collected from virgin areas and from adjacent cultivated fields, indicate that many soils contain less than one-half as much nitrogen and organic matter as was present under virgin conditions. Sheet and gully erosion have been responsible for a part of this decrease. Tillage accelerates the rate of decomposition of the organic matter in the soil, and the removal of crops also is an important factor in the gradual decrease in available plant nutrients, because grain and forage contain large quantities of nitrogen and other minerals needed for plant growth.

A preliminary study of the acidity in the soils of this county indicates that marked differences occur in soil reaction. The results of analyses of 151 samples of surface soil, collected from different parts of the county show that 10 soils are basic, or alkaline, which means that a good supply of lime is present; 55 are neutral and would produce crops like alfalfa and sweetclover without the addition of lime; 29 are slightly acid; 19 are slightly acid +; 21 are medium acid; 3 are medium acid +; and 14 are strongly acid. A study of the reaction of the subsurface soils indicates that lime and other basic materials are not so abundant in the subsurface layers as in the surface soils. This is a normal condition in soils that have not been severely

[2] This section of the report was written by H. J. Harper, professor of soils, agronomy department, Oklahoma Agricultural and Mechanical College.

leached, because vegetation tends to preserve the lime content of the surface layers as a result of the absorption of basic elements from different parts of the soil profile, by the roots of plants, and the concentration of these elements in the surface layer as a result of decomposition of leaves and stems which fall on the ground. Leaching, which results from the percolation of rain water through the soil, removes basic material present in the films of water surrounding the soil particles and gradually increases the acidity of the subsurface layers. Soils which are porous and contain a comparatively high proportion of sand are, in general, more thoroughly leached than soils containing a high proportion of clay.

The use of limestone to correct soil acidity is important, because many crops make a better growth in soils that are neutral or only slightly acid than in soils which are medium or strongly acid. Experiments indicate that sweetclover, lespedeza, soybeans, and many other legumes, planted in acid soils, respond to applications of limestone, and because these crops will be needed to maintain and increase the nitrogen content of the soils in this county, it will be necessary to apply considerable quantities of limestone to many soils, in order to provide conditions more favorable for the maximum growth of the crops mentioned.

Studies on the phosphorus content of 93 surface soils, samples of which were collected from different parts of the county, indicate that deficiency of phosphorus is also an important problem. Only 4 of the samples analyzed are very high in readily available phosphorus, 22 are high, 15 are medium, 21 are low, and 31 are very low. The readily available phosphorus in these samples was determined by extracting the soil with fifth-normal sulphuric acid. The use of phosphates in the fertilizer is more important than the use of lime, in increasing the yield of many crops planted on nonacid soils which still contain a good supply of organic matter and nitrogen. Applications of phosphate fertilizer and limestone are needed on the acid soils, in order to provide conditions favorable for maximum crop production.

Experiments conducted in McIntosh County show that applications of a phosphate fertilizer to soils deficient in readily available phosphorus have produced marked increases in crop yields. Table 5 shows the effect of rate of applications of 16-percent superphosphate and complete fertilizers, containing different quantities of nitrogen

TABLE 5.—*Effect of rate of application and composition of fertilizers on yield of corn and soybeans grown on Bates fine sandy loam, 6½ miles north of Eufaula, Okla.*

Plot no.	Soil amendment	Rate of application per acre	Acre yield of corn	Acre yield of soybean hay [1]	Plot no.	Soil amendment	Rate of application per acre	Acre yield of corn	Acre yield of soybean hay [1]
		Pounds	*Bushels*	*Pounds*			*Pounds*	*Bushels*	*Pounds*
1	None	----------	18.0	2,631	5	0-16-0	200	27.4	5,555
2	0-16-0	100	24.6	5,103	6	2-12-2	266	27.6	----------
3	2-12-2	133	24.1	----------	7	4-12-4	266	28.2	7,374
4	4-12-4	133	28.8	4,985					

[1] Laredo soybeans were planted on Apr. 20 and harvested on Oct. 1, 1929.

and potash, on the yield of corn and soybeans grown on Bates fine sandy loam.

Phosphorus is the chief limiting factor, from the point of view of soil fertility, in the production of corn and soybeans on this soil at present, although a 4–12–4 fertilizer, applied at the rate of 266 pounds an acre, produced a larger yield of soybeans than was obtained from an application of 200 pounds of superphosphate containing an equivalent amount of phosphorus. These experiments indicate that the production of forage could be doubled under normal conditions and that more livestock could be maintained on the average farm as a result of the increase in the production of feed.

Sweetclover also responds to fertilization on many soils. The effect of applications of phosphate and finely ground limestone on the growth of this crop is given in table 6.

TABLE 6.—*Effect of applications of agricultural limestone, farm manure, and other soil amendments on the yield of sweetclover grown on Bates fine sandy loam, 7 miles north of Eufaula, Okla.*

Plot no.	Soil amendment	Rate of application per acre	Acre yield of sweetclover hay	Plot no.	Soil amendment	Rate of application per acre	Acre yield of sweetclover hay
		Pounds	*Pounds*			*Pounds*	*Pounds*
1	None		192	8	Limestone	6,000	3,043
2	Limestone	6,000	695		Rock phosphate	400	
3	Rock phosphate	400	849	9	Limestone	6,000	5,363
4	Superphosphate	200	1,367		Superphosphate	200	
5	Manure	12,000	2,199		Muriate of potash	100	
6	Manure	12,000	3,078	10	Limestone	6,000	3,996
	Superphosphate	200			Rock phosphate	400	
7	Limestone	6,000	3,626		Muriate of potash	100	
	Superphosphate	200					

In this particular test an application of 3 tons of finely ground limestone an acre did not produce enough sweetclover to be profitable, and rock phosphate or superphosphate did not produce satisfactory yields when applied alone. The best yields of sweetclover were obtained from applications of farm manure; manure and superphosphate; superphosphate and limestone; limestone and rock phosphate; and limestone, with superphosphate or rock phosphate, and potash.

Tests on the availability of potassium in acid sandy soils indicate that it will be necessary to apply potash fertilizers on many of these soils, in order to maintain or increase crop yields, especially where forage crops are grown and removed from the land. The deficiency of potash is not an important problem on soils that are not acid or contain a considerable quantity of clay in the surface or subsurface layers. Soils which receive liberal applications of farm manure usually contain sufficient quantities of potash to support a normal growth of ordinary field crops.

The effect of fertilization on the yield of cotton is given in table 7. This experiment was conducted over a period of 3 years on a farm located 6½ miles north of Eufaula on the road to Checotah.

A, An excellent cropping practice—one row seeded to cowpeas and two planted to corn; *B*, a good crop of oats on Parsons *silt* loam.

A, Result of erosion on an unterraced area of Teller fine sandy loam, formerly under cultivation; *B*, road almost ruined by erosion.

TABLE 7.—*Effect of applications of soil amendments on the yield of cotton grown on Bates fine sandy loam*[1]

Plot no.	Soil amendment	Rate of application per acre	Average acre yield of seed cotton	Plot no.	Soil amendment	Rate of application per acre	Average acre yield of seed cotton
		Pounds	*Pounds*			*Pounds*	*Pounds*
1	None		600	5	16-percent superphosphate	320	846
2	16-percent superphosphate	200	700		Nitrate of soda	60	
3	16-percent superphosphate	200	726		Kainit	20	
	Nitrate of soda	100		6	Manure	16,000	1,000
4	16-percent superphosphate	200	826	7	Manure	16,000	1,013
	Kainit	25			16-percent superphosphate	200	

[1] Average for 3 years (1925–27).

These data show that soil fertility is a very important factor in the successful production of cotton. The addition of superphosphate, applied in the row at time of planting, produced a larger increase in yield than an application of nitrate of soda. A complete fertilizer containing superphosphate, nitrate of soda, and kainit produced slightly more cotton than a fertilizer containing only superphosphate and kainit. Superphosphate, with the addition of farm manure, at the rate of 8 tons an acre, produced larger yields than any other treatment. This information indicates that a livestock system of farming could be used to advantage to improve crop yields and would be less expensive in maintaining yields over a long period. The variety of cotton grown is more important in determining crop yields on many soils than the application of fertilizers. Damage from the boll weevil is very common, and such varieties as Early Triumph, Dixie Pine Land 11, Rowden 40, and early strains of Acala have produced higher yields than many other varieties which have been tested in this part of the State. Early-maturing varieties of corn also produce better yields on the upland soils than late-maturing varieties which mature during a period when a lack of moisture, together with a high temperature, is unfavorable for plant growth.

A study of the potential fertility of the soils in this county is given in table 8. Most of the soil samples were obtained from uncultivated areas, and the percentage of total nitrogen is higher than it would be in samples collected from cultivated land. A comparison of a cropped and virgin soil taken from an area of Bates fine sandy loam is shown by the results of the analyses of samples 105 and 106 in table 8. More than 50 percent of the nitrogen in the virgin soil has disappeared since this area has been in cultivation. The acidity in these samples is expressed in pH values. A pH value above 7 indicates that the soil is not acid and the lime content is usually high. Soils having a pH value below 7 are acid, and the acidity increases as the pH value decreases. A soil with a pH value of 4.9 is very strongly acid. A wide difference exists in the acidity in different parts of some of the soil profiles.

TABLE 8.—*Chemical composition of samples of several virgin soils from McIntosh County, Okla.*

SOILS OF THE UPLANDS

Soil type and sample no.	Location	Depth	pH	Total nitrogen	Total organic matter	Total phosphorus	Readily available phosphorus[1]
		Inches		*Percent*	*Percent*	*Percent*	*Parts per million*
Bates fine sandy loam:							
3350	SW¼NW¼ sec. 21, T. 11 N., R. 17 E.	0–16	6.5	0.090	1.94	0.014	1
3351		16–32	5.9	------	------	------	1
3352		32–38	5.8	.043	.49	.011	1
3353		38–44	6.8	.024	.16	.013	1
Bates fine sandy loam:							
105	NE¼NE¼ sec. 36, T. 11 N., R. 16 E.	0–6	6.6	.127	------	.027	14
106[2]		0–6	5.8	.059	------	.018	6
Bates loam, reddish-subsoil phase:							
3342	SE¼NE¼ sec. 30, T. 12 N., R. 17 E.	0–10	6.1	.154	3.23	.021	0
3343		10–18	5.9	.094	1.89	.020	0
3344		18–30	6.1	.073	1.13	.019	0
3345		30–48	6.6	.043	.24	.024	0
Bates silt loam:							
3337	SE¼SW¼ sec. 2, T. 11 N., R. 17 E.	0–15	5.8	.130	2.98	.014	32
3338		15–22	5.9	.066	1.16	.010	32
3339		22–36	6.9	.049	.56	.011	30
3340		36–44	7.0	.050	.62	.009	32
Hanceville fine sandy loam:							
3380	SE¼SW¼ sec. 20, T. 11 N., R. 18 E.	0–4	6.8	.053	1.23	.009	0
3381		4–14	6.2	.021	.09	.008	0
3382		14–24	5.1	.020	.26	.012	0
3383		24–34	4.9	.016	.11	.007	0

SOILS OF THE TERRACES

Brewer very fine sandy loam:							
910[1]	SE¼SW¼ sec. 13, T. 10 N., R. 16 E.	0–6	5.8	0.110	------	0.034	60
Brewer very fine sandy loam:							
3359	SE¼NW¼ sec. 4, T. 10 N., R. 16 E.	0–12	6.7	.076	1.41	.019	28
3360		12–22	6.3	.041	.75	.007	1
3361		22–36	5.6	.036	.51	.009	6
3362		36–50	5.5	.010	.00	.010	22
Brewer clay:							
3364	NW¼NW¼ sec. 22, T. 10 N., R. 16 E.	0–6	7.3	.274	7.83	.061	80
3365		6–36	5.8	.093	2.81	.036	72
3366		36–40	7.5	.063	1.48	.030	80
3367		40–50	8.4	.037	.42	.027	80
Brewer clay:							
3369	NE¼NE¼ sec. 19, T. 11 N., R. 16 E.	0–10	6.1	.156	2.48	.061	60
3370		10–22	5.6	.091	1.24	.035	40
3371		22–32	5.7	.061	.95	.025	42
3372		32–44	7.1	.043	.57	.035	96
Stidham fine sand:							
907[2]	NW¼NW¼ sec. 19, T. 10 N., R. 18 E.	0–6	6.8	.055	------	.012	24
Teller fine sandy loam, rolling phase:							
3373	NE¼SE¼ sec. 9, T. 9 N., R. 16 E.	0–4	8.1	.039	.88	.010	2
3374		4–26	7.7	.016	.27	.006	1
3375		26–31	6.6	.014	.13	.005	4
3376		31–40	5.3	.026	.18	.011	4
3377		40–60	5.2	.017	.35	.012	1
3378		60+	5.6	.013	.11	.004	0

[1] Samples of soil extracted with fifth-normal sulphuric acid, 1 part of soil to 10 parts of solution. When the available phosphorus is more than 25 p. p. m., a profitable response from phosphorous fertilization will not be obtained from field crops commonly produced in this county.

[2] Cropped soil.

TABLE 8.—*Chemical composition of samples of several virgin soils from McIntosh County, Okla.*—Continued

SOILS OF THE FIRST BOTTOMS

Soil type and sample no.	Location	Depth	pH	Total nitrogen	Total organic matter	Total phosphorus	Readily available phosphorus[1]
		Inches		*Percent*	*Percent*	*Percent*	*Parts per million*
Perry silty clay:							
3384	SE¼SE¼ sec. 30, T. 12 N., R. 15 E.	0–10	6.1	0.146	2.90	0.038	20
3385		10–18	5.7	.083	1.34	.024	8
3386		18–24	6.3	.089	1.72	.029	4
3387		24–40	6.1	.067	.92	.018	1
3388		40–55	7.5	.050	.53	.017	1
Yahola very fine sandy loam:							
3347	NE¼SE¼ sec. 22, T. 9 N., R. 16 E.	0–22	8.3	.044	.82	.021	96
3348		22–38	8.3	.100	1.87	.040	128
3349		38–50	8.5	.033	.38	.024	72

A study of the total phosphorus content of these soils indicates that the potential supply of this element is low under virgin conditions, but that the ready availability of the phosphorus is variable. The content of available phosphorus in acid soils tends to be smaller than the content in neutral or basic soils. Not all acid soils, however, are low in readily available phosphorus. Soils derived from alluvial materials of recent origin contain more readily available phosphorus, as a rule, than upland soils.

A comparison of the chemical analyses of Parsons silt loam obtained from other counties in Oklahoma indicates that the average readily available phosphorus content of this soil is lower than the content of samples from this county. In general the surface soils of the Parsons soils range from medium to strongly acid. The Bates soils, as a rule, are thoroughly leached, and the acidity given in table 8 is typical for these soils, although the phosphorus content of samples 3337 to 3340 is much higher than the average for this type. The composition of the Stidham soils depends to some extent on the degree of leaching which has taken place during their development and the character of the material from which these soils are derived. As a rule, these soils have low potential fertility. The nitrogen content of cropped areas is very low, and complete fertilizers should be used in order to obtain maximum yields of most crops. The Brewer soils are in many places higher in total organic matter than the analyses of samples 3359 and 3369 indicate. As these soils occur on high terraces and conditions are favorable for the absorption of a high proportion of the rainfall, it is logical to expect that the soil material should be acid. The use of limestone and legume crops is the most important treatment that should be used to maintain the productivity of these soils for a considerable period of time. Information in regard to the lime requirement of different fields may be obtained by sending samples of soil (for analyses) to the Oklahoma Agricultural Experiment Station, Stillwater, Okla.

The rolling phase of Teller fine sandy loam is not typical of the Teller soils because of its low potential fertility. The analyses indicate that the parent material from which this soil is derived is low in total phosphorus. Most of the Teller soils are very productive, but the rolling phase is not a fertile soil, although its physical properties are very desirable, as regards tillage and the absorption of moisture.

Some of the bottom land in this county produces good crops of alfalfa without fertilization, when overflows do not interfere with plant growth. The soils on the high terraces along Canadian River, especially the Brewer soils, are productive when properly managed, and most of them do not respond to applications of fertilizer. The Yahola, Verdigris, and Perry soils occur in areas subject to overflow and contain more available lime and phosphorus than the soils of the terraces and uplands. These soils are productive when a good system of farming is used and serious damage from overflow does not occur. Some soils, such as Perry silty clay, contain an adequate supply of plant nutrients, but average crop yields are low because these soils are subject to frequent overflow and internal drainage is poor.

A knowledge of soil conditions is essential for the successful operation of every farm in McIntosh County. Cropping systems must be used which will maintain the nitrogen content of the soil, and limestone and other fertilizers must be applied where they are needed to produce maximum yields at a minimum cost. Those soils favorable for the development of a more intensive type of agriculture should be kept in cultivation, and cultivated land that will not respond to good management should be returned to permanent pasture or forest.

EROSION-CONTROL AND SOIL-IMPROVEMENT PRACTICES

The effects of destructive soil erosion are menacing to the general welfare of the inhabitants in this section of the State. Soil erosion on many of the sloping lands has been comparatively rapid and destructive because little or no effort has been made to check its progress. Most of the land has been under cultivation only two or three decades, but practically all the sloping land is not managed in a way to prevent erosion and is deteriorating rapidly. Many of the upland soil types of McIntosh County are sloping and have developed textural and structural characteristics which make them distinctly erosible when the surface is exposed to the moderately high annual rainfall of nearly 40 inches. Evidence that the erosivity of such soils is high, especially as winter cover crops are seldom grown, is shown by the many gullied fields, of which only a few are protected by terraces. Considerable areas of cultivated land occur in valleys which receive run-off from the adjoining higher lands. A large proportion of the more sloping soils originally were forested, and as a tree type of vegetation does not provide a large quantity of organic matter, the water-holding capacity of these soils is not great.

Continued cultivation of land under these conditions has caused the removal of large quantities of the richer topsoil, greatly depleted the supply of available plant nutrients, and to a great extent impaired the general tilth of the land. It seems probable that an average of at least 6 inches of the topsoil has been removed since cultiva-

tion was begun on some of the older cultivated soils having a slope of 4 percent or more. As the topsoil becomes thinner, erosion is accelerated, because of the lower water-holding capacity of the soil and increased run-off.

Many fields have been seriously dissected by gullies which are constantly increasing in number and size, and a number of the older fields have been abandoned as worthless for cultivation (pl. 2, *A*). Some fields have reached this stage after being under cultivation less than 18 years. This destructive erosion is a very serious menace, and its inroads should be checked as effectively as possible in the immediate future.

Terracing is one of the most dependable methods in checking soil erosion and water losses in cultivated fields. The broad-based, or Mangum, terrace is best suited for the gently sloping soils, whereas the steeper slopes require a terrace with a much narrower base which cannot be cultivated advantageously over the top. The several crops are planted in rows parallel to the crest of each terrace and cultivated along the contours. The distance between the terraces on the steeply sloping land ranges from 10 to 30 yards and on the less sloping land, where the Mangum terraces are used, from about 25 to 50 yards. The fall between the terraces ranges from about 2½ to 5 feet, and the gradient of the waterway along the length of the terrace is about 1 or 2 inches in a hundred feet. The higher crest of the very gradual level is about 2 feet above the lower part of the ditch or waterway. With broad outlets and well-constructed baffles of rock slabs or other durable material to maintain the correct gradient, it is not difficult to keep the terraces in first-class shape. Where the water from several terraces empties into graded roads, it is a wise precaution to baffle the grader ditch with stone, concrete, or other material at intervals ranging from 2 to 4 rods, in order to prevent a deep ditch from forming and at the same time protect the terrace baffles near the fence line. On the rolling sandy soils, especially, the grader ditches could easily be graded so that the ditches would be broad and shallow, then baffled every few rods, and carefully seeded to Bermuda grass or other sod-forming grasses, in order to prevent erosion from cutting the ditches deeper. In numerous places, roadside drainage ditches have cut so deeply that gullying is rapidly extending into the adjoining fields, causing ruin to both roads and fields, and some roads have already been abandoned. In places where terraces terminate at roads, such precautions are necessary, otherwise the terrace baffles will soon be cut out and a large ditch will extend up the terraces as the road ditches cut deeper (pl. 2, *B*).

Terracing to prevent erosion is not a new idea. All European and some Asiatic countries have used various kinds of terraces for centuries. The necessity for preventing soil erosion in the light-textured Norfolk soils in Georgia and the Carolinas became apparent prior to the Civil War. Now, well-maintained terraces are common over all the Gulf States, and they are becoming more and more common in the North, especially along the larger inland valleys, such as the Mississippi, Missouri, Arkansas, Ohio, and other valleys, where the annual rainfall is high and there is much very sloping land.

Although the prevention of erosion is of primary importance, other advantages, especially the conservation of water, accrue from terrac-

ing on sloping cultivated land. The more vigorous vegetation resulting from the increased supply of water in the soil is frequently the chief advantage of the terraces in controlling erosion. A program of soil building is possible, and yields can be gradually increased, because well-constructed terraces prevent further serious loss of plant nutrients, that would otherwise take place through erosion. The slow run-off of rainfall makes the land not only more absorptive but more retentive of moisture. As the humus content is increased by stable manure or green-manure crops, the water-holding capacity of the soil also is increased. The conservation of moisture made possible by terracing is a highly important factor in the restoration and maintenance of soil fertility. A much greater proportion of the rainfall is conserved during showers in midsummer when all the available moisture is most needed. Soil-improvement practices can be started, which, on unterraced land, would not be nearly so effective or enduring. On land where commercial fertilizer is used, its properties are not only more effective but more lasting. The agricultural value of well-terraced land is maintained at a much higher level than that of unterraced land which is allowed to deteriorate by washing and gullying.

Soil-saving dams would be advantageous in many places. This type of dam is similar to any other, but ordinarily it is built along a fence or road in a gully or other drainageway where small drains converge and concentrate the surface run-off from the area under consideration. While the dam is under construction, an underpass is built of stone or concrete, to carry the run-off from the average shower. A perpendicular elbow is built just inside the dam continuous with the underpass, and raised to sufficient height by drain pipes so that considerable water will be impounded, from which the sediments can settle. This upright pipe of stone or concrete is raised a foot or more from time to time as the accumulation of sediments approaches the top of the pipe. Eventually the sediments will completely fill the ditch and cover the adjoining land if desired. Even if this process takes several years, the ditches are filled, soil loss by erosion and gullying is stopped, after which, by careful terracing, the land can be kept under cultivation and become more valuable.

Some farmers practice strip cropping on the more gentle slopes. These strips are, in general, a rod or two wide and consist either of sod or some thickly sown crop which will hold the soil sediments from run-off causing sheet erosion. The strips are placed at certain contour intervals across the slopes, and the land between the sod strips is cropped along the contour. At intervals the sod strips can be cultivated and newly seeded grass strips laid out to control erosion. When gullying once starts, however, it is generally best to terrace the land. In the final analysis, a vigorous plant growth is the best protection against soil erosion; terraces, dams, and other devices are largely valuable, so far as they contribute toward that primary objective.

In most of the upland soils, the scarcity of organic matter and nitrogen are the chief drawbacks to the production of crops. A more general practice of growing sweetclover, Austrian Winter peas, cowpeas, soybeans, hairy vetch, and mung beans would greatly increase the supply of organic matter, if these crops are used for pasture

and subsequently turned under, or a green-legume crop occasionally turned under. Such crops not only increase the soil fertility and retard erosion but provide cheap feed for the livestock which should be kept to balance the agriculture and provide a safe and sane system of farming under varying economic conditions. Inasmuch as the average renter cannot afford or is not allowed to grow such crops, it is incumbent on the landowner to make provision for a more improved cropping system if he expects to maintain or improve the productivity of his soil or enhance its value.

MORPHOLOGY AND GENESIS OF SOILS

McIntosh County lies on the border line of the great prairie region and the Ouachita province. This explains the fact that the topographic features range from very steep and rolling to gently undulating and almost flat. Because of the wide differences in relief, the soils, after being subjected to various soil-forming processes, have developed a number of distinct soil characteristics. Under the prevailing environment, the mean annual precipitation of nearly 40 inches has leached the soils of any carbonates present to a depth ranging from 2 to 6 feet, depending largely on the fineness of the disintegrated parent material and on the degree of slope. The residual parent soil materials are derived mainly from fine-grained sandstone and shale, and the soil-forming processes acting on these materials, which differ not only in texture but in chemical composition, have produced highly significant soil characteristics; there is only one small remnant of limestone rock in the county, at the intersection of sections 3, 4, 9, and 10, T. 12 N., R. 17 E.; and the other soils have developed from very old and very recent alluvium.

A large proportion of the soils are light in color, as they have developed in forest-covered areas and are not high in organic matter as are soils developed under grass vegetation. Trees ordinarily grow on the rougher and more sloping upland areas most susceptible to erosion. The Prairie soils are both dark and light colored—those having heavy tenacious subsoils have gray-brown topsoils, and those having friable subsoils have fairly dark topsoils.

Normal virgin soils are soils fully developed from weathered parent materials by the soil-forming processes. The smooth prairie land, which occurs in the central and northern parts of the county, has become stabilized under the influence of the climatic and vegetative environment, and it represents the normal or, at least, the best developed soils of the county. These soils have developed under a cover of tall prairie grasses (chiefly *Andropogon* sp.). The soils derived mainly from fine-grained sandstone material and a small proportion of shale have developed dark topsoils formed largely from the decay of grass roots, and they have friable or moderately friable subsoils. These are the Bates soils, and some of them are the most productive Prairie soils in the county. Following is a description of a typical profile of Bates silt loam as observed 220 yards west of the half-section corner on the south section line of sec. 2, T. 11 N., R. 17 E.:

1. 0 to 15 inches, dark-brown or dark grayish-brown silt loam containing a few iron pellets. The reaction is slightly acid.
2. 15 to 22 inches, brown or light-brown structureless silt loam containing a few iron accretions of semihard pellets averaging about one-tenth of an inch in diameter. The reaction is medium acid.

3. 22 to 36 inches, pale-yellow or grayish-yellow silt loam grading toward very fine sandy loam or fine-textured loam. The material is structureless or single grained. The reaction is medium acid.
4. 36 to 44 inches, light-brown or yellowish-brown mottled and splotched friable silty clay or clay containing numerous semihard accretions. The reaction ranges from slightly acid to medium acid.
5. 44 to 50 inches+, light-brown or yellowish-brown moderately friable clay mottled with somewhat splotched yellow and rust-brown moderately plastic clay. This layer contains some semihard iron concretionary material. The reaction is slightly acid.

Bates silt loam and Bates fine sandy loam are the most extensive soil types of this series.

Table 9 shows the results of mechanical analyses of samples of several layers of Bates silt loam.

TABLE 9.—*Mechanical analyses of Bates silt loam*

Sample no.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
451936	Surface soil, 0 to 15 inches	1.0	1.0	0.9	5.4	12.7	63.7	15.3
451937	Subsurface soil, 15 to 22 inches	1.4	1.5	.9	5.6	13.8	66.4	10.4
451938	Subsoil, 22 to 36 inches	2.6	2.4	1.2	5.0	11.4	54.8	22.6
451939	Subsoil, 36 to 44 inches	1.7	1.5	1.0	3.9	8.8	44.9	38.2

In the northern part of the county the larger areas of smooth prairie land have developed from shale containing a comparatively small percentage of very fine sand grains and a high percentage of clay particles. The translocation of the finer particles from the topsoil to the lower horizons has given rise to a dense claypan subsoil which has so restricted underdrainage that the surface soil is not only highly acid, but the color is grayish brown. Dispersion of clay in the upper horizons of the soil allowed it to move downward to a point where an exchange reaction for calcium and magnesium took place. This caused flocculation of the clay and thereby produced a hardpan of varying impermeability. The leaching of soluble bases, together with magnesium and calcium carbonates, and the removal of sesquioxides from the surface layers are dominant in the soil-forming process. These soils are the Parsons soils which were first mapped in the vicinity of Parsons, Kans., and are common in the eastern part of the prairie region. In McIntosh County, however, the color of the topsoil averages slightly lighter gray than in the Parsons soils in southeastern Kansas. Following is a description of a typical profile of Parsons silt loam, as occurring in McIntosh County:

1. 0 to ¼ inch, a layer of brown organic matter mixed with very fine sand and silt.
2. ¼ to 18 inches, gray or light-brown structureless silt loam.
3. 18 to 26 inches, more pronounced gray material than in the layer above, with noticeable brown stains and soft accretions. The texture is silt loam or very fine sandy loam.
4. 26 to 30 inches, light-brown or grayish-brown heavy dense clay containing a high percentage of bright rust-brown or reddish-brown mottling. When crumbled while wet the clay is very plastic and shows an intricate array of glassy cleavage planes. When dry the mass has a dull color and a blocky structure.

5. 30 to 48 inches, light-brown or gray clay mottled mainly with yellowish brown. The material contains a few black soft accretions. This and the overlying layer are the layers of maximum density.
6. 48 to 56 inches +, gray or brown silty clay which is consistently less dense than that in the two overlying layers but is compact and firm in place. The rust-brown and yellowish-brown mottlings are less numerous, and the cleavage planes do not show any darker discoloration as in the two overlying layers.

The Parsons soils occur on nearly flat broad divides and the adjoining gentle slopes. The sloping areas are designated as a slope phase which differs mainly in having a thinner topsoil and a more brown claypan with a higher percentage of rust-brown stains and iron concretionary material. Probably the heaviest claypan development is in the vicinity of Stidham, where the soils seem to have been modified by inundation of the more quiet waters of some ancient overflow period. This is substantiated by the fact that carbonates may either occur sparingly or in abundance below the claypan layer and are also associated with a generally higher percentage of iron concretions.

The soils on the higher terraces which border the first-bottom alluvium of the three principal streams entering the county from the west, appear to be the rolling margins of a very high old stream terrace. The subsoils and substrata consist mainly of reddish-yellow and yellowish-red fine sandy clays similar to those of the low first bottoms, which have been formed from overflow sediments originating in the Permian "Red Beds" country of western Oklahoma. These soils are comparatively young and are undergoing a very rapid change, owing to their high susceptibility to erosion when under cultivation. Most of them contain some carbonate of lime in the reddish-brown friable fine sandy clay subsoils and, for the most part, are productive. These soils can withstand a far greater degree of wastage from erosion, without serious impairment of their productivity, than the Parsons soils. The Teller soils comprise the principal areas of these soils. They have developed under a forest cover. A description of a profile of Teller fine sandy loam follows:

1. 0 to 4 inches, structureless grayish-brown loamy fine sand or fine sandy loam. The reaction is neutral.
2. 4 to 26 inches, light-brown loamy fine sand containing considerable organic matter but less than the layer above. The organic matter is not uniformly distributed. The reaction is slightly acid.
3. 26 to 31 inches, light-brown or yellowish-brown very fine sand grading into irregular lumps of reddish-brown fine sandy clay. Considerable splotching of lighter brown or slightly reddish brown, caused by intrusions of insects, occurs. The reaction is medium acid.
4. 31 to 40 inches, reddish-brown or light-red very fine sandy clay which is very sticky when wet and is hard and compact when dry. The material cracks very little because of the high content of sand. The reaction is medium acid.
5. 40 to 60 inches, reddish-brown very friable fine sandy clay having a slightly lower content of clay than the layer above. The reaction is medium acid.
6. 60 inches+, light-brown or reddish-brown loamy very fine sand which is probably a fair representation of the material first laid down by overflow waters. At this level, however, on lower slopes the soil material in places shows evidence of stratification and consists of many layers, in most places ranging from 2 to 4 inches in thickness, from fine sand to silty clay in texture, and from light brown to reddish brown in color.

The Teller soils are not very extensive. Associated with them, but more leached and less red, are the Stidham soils.

Lying from 25 to 30 feet above the first bottoms of Canadian and North Canadian Rivers are a number of widely separated areas of dark-colored second-bottom soils known as the Brewer soils which range in texture from very fine sandy loam to clay. They are composed largely of soil materials transported from the plains of western Oklahoma. These soils have developed on smooth but slightly sloping relief. Most of them are well drained. In places, at a depth ranging from 3½ to 5 feet, these soils contain carbonate of lime. They are very fertile. They are mainly dark colored, have permeable subsoils, and are suited to a wide range of crops.

The more rugged and rough highland areas comprise ridges covered by layers of sandstone, which have protected and kept from complete removal by erosion the land occupied by Hanceville soil materials. In places where the stony material has disintegrated to a greater depth, the ridges are smooth and the soil material is deeper and less stony, giving rise to soils of the Hanceville series. These soils have developed under a forest growth of hardwoods, and in the smoother locations the parent material lies at a depth of several feet, but most of the parent material of sandstone is only partly weathered and lies at a depth ranging from 2 to 3 feet. The greater proportion of the Hanceville soils in this county are so shallow and stony as to be unsuited for farm crops.

Hanceville fine sandy loam, where typically developed, has a 2- or 3-inch layer of light-colored sandy material grading into reddish-yellow or yellowish-red light sandy material which, with increase to a depth ranging from 10 to 20 inches, grades into reddish-yellow or red friable sandy clay or fine sandy loam, and this, in turn, grades into disintegrated sandstone at a depth ranging from 2 to 4 feet. Hanceville fine sandy loam is low in organic matter and in plant nutrients, is open in structure, and leaches readily.

The Talihina soils, probably developed entirely under prairie conditions, occupy high ridges and rolling areas, and in most places they are very thin, having developed from thick beds of shale covered in places by a thin layer of broken sandstone.

The soils developed from alluvium comprise soil materials washed mainly from two great areas. Those occupying the flood plain of Canadian River have been transported largely from the western plains of Oklahoma and are highly calcareous. The red soils, which for the most part are very fertile, are included in the Yahola series, and the very light colored soils, which are of low productivity, in the Lincoln series.

Along the other streams, the soil materials have been transported chiefly from the humid soils of the prairie, intermixed with some sandy soil materials also of the humid section. These soils are brown and are not calcareous. Those having good drainage and which are for the most part well supplied with plant nutrients are included in the Verdigris series. These soils occur chiefly in the creek bottoms, to considerable extent along North Canadian River, and to less extent along Deep Fork. The brown alluvial soils having poor drainage and lying chiefly along Deep Fork are included in the Perry and Lightning series. The Lightning soils are darker and have slightly better natural drainage than the Perry soils.

Table 10 gives the pH values of several soils of McIntosh County, Okla. These determinations were made in the laboratories of the Bureau of Chemistry and Soils by the hydrogen-electrode method.

TABLE 10.—*pH determinations on four soil profiles in McIntosh County, Okla.*

Soil type and sample no.	Depth	pH	Soil type and sample no.	Depth	pH
Brewer clay:	*Inches*		Bates fine sandy loam:	*Inches*	
451910	0- 6	7.0	451932	0-16	6.0
451911	6-36	6.3	451933	16-32	5.6
451912	36-40	7.3	451934	32-38	5.6
451913	40-50	8.1	451935	38-44	5.8
Teller fine sandy loam, rolling phase:			Bates silt loam:		
451914	0- 4	7.0	451936	0-15	5.8
451915	4-26	6.6	451937	15-22	5.5
451916	26-31	6.3	451938	22-36	5.9
451917	31-40	5.5	451939	36-44	6.2
451918	40-60	5.2			
451919	60-70+	5.6			

SUMMARY

McIntosh County is in the eastern part of Oklahoma. It includes an area of 708 square miles, or 453,120 acres. It is mainly rolling prairie land, and large bodies of rough hills and ridges of sandstone represent a part of the Ouachita province. Several large streams, Canadian and North Canadian Rivers and Deep Fork, flow through the county and have wide flood plains of flat land bordered by high old terrace benches which have been largely eroded, and the relief is rolling.

The population in 1930 was 24,924, all of which is classed as rural. The largest towns, Eufaula and Checotah, have less than 2,500 inhabitants each. The people are largely native whites, though a large number of Indians, mostly Creeks, and many Negroes live in the county.

The climate is mild, and the average annual rainfall is adequate for growing crops, though short summer droughts sometimes occur and injure the corn crop.

Cotton, corn, grain sorghums, sorgo, and prairie hay are the principal crops, and in some sections truck crops, mainly onions and potatoes, are produced for outside markets.

Much of the land is tillable, but large areas of the sandstone ridges and hills, as well as some eroded slopes of the smoother rolling lands, are not suitable for cultivation.

On the basis of similarities in crop adaptations and general features relating to agricultural values the soils are divided into seven groups as follows: Prairie soils with moderately friable subsoils; Prairie soils with claypan subsoils; forested upland soils; dark-colored soils of the second bottoms, or terraces; well-drained alluvial soils; imperfectly drained alluvial soils; and miscellaneous soils and land types.

The soils in group 1 are the Bates soils. These are moderately dark Prairie soils which have heavy subsoils readily penetrated by water and plant roots. These soils, which are among the most extensive in the county, have grayish-brown surface soils and yellow crumbly clay subsoils. They are fairly productive and are well suited to the principal crops grown—cotton, corn, and sorghums.

Group 2 comprises the Parsons soils which are Prairie soils, having grayish-brown surface soils and yellow claypan subsoils. They are smooth and fairly productive but not so good for corn as are the Bates soils. Cotton, grain sorghums, and prairie hay do well, and these crops are grown extensively. Small grains, though not so extensively grown, yield fairly well.

Group 3 consists of light sandy soils with friable sandy or sandy clay subsoils. These soils are low in organic matter, and most of them are not highly productive, but they respond well to good management and to the incorporation of organic matter and fertilizers. They are fairly well suited to the regular farm crops of cotton, corn, and feed crops, though yields are very low on the deep sandy soils and on the eroded areas of the less sandy soils. These soils have developed under a forest cover. A large proportion of them is farmed. The soils of this group which have been developed from old alluvial deposits on the high terraces are included in two series—the Teller soils, having brown topsoils and reddish-brown subsoils, and the Stidham soils having grayish-brown topsoils and yellow or yellowish-brown subsoils. Hanceville fine sandy loam, also of this group, has developed from sandstone that in many places lies near the surface and has not weathered deeply.

The soils of group 4 (the Brewer soils) have dark-brown friable topsoils and friable or crumbly brown subsoils. These soils have developed from old alluvium deposited on high flat terraces several feet above the present flood plains. They are highly productive valuable agricultural soils, well suited to many crops but utilized almost entirely for cotton, corn, sorghums, and other feed crops.

Group 5 comprises well-drained valuable agricultural soils developed from alluvium, highly suited to cotton and corn, which are the chief crops grown. The reddish-brown calcareous soils belong to the Yahola series. They occupy large areas in the Canadian River bottoms. Some associated soils in this bottom land, which are calcareous and very light grayish brown, are included in the Lincoln series. These soils are not highly productive, as the only representative of the series in this county is a fine loose sandy soil. Brown soils of the other stream bottoms are composed of soil materials which are not calcareous and range from highly productive to moderately productive. They are members of the Verdigris series. These soils are moderately well drained and largely under cultivation, mainly to cotton, corn, and feed crops.

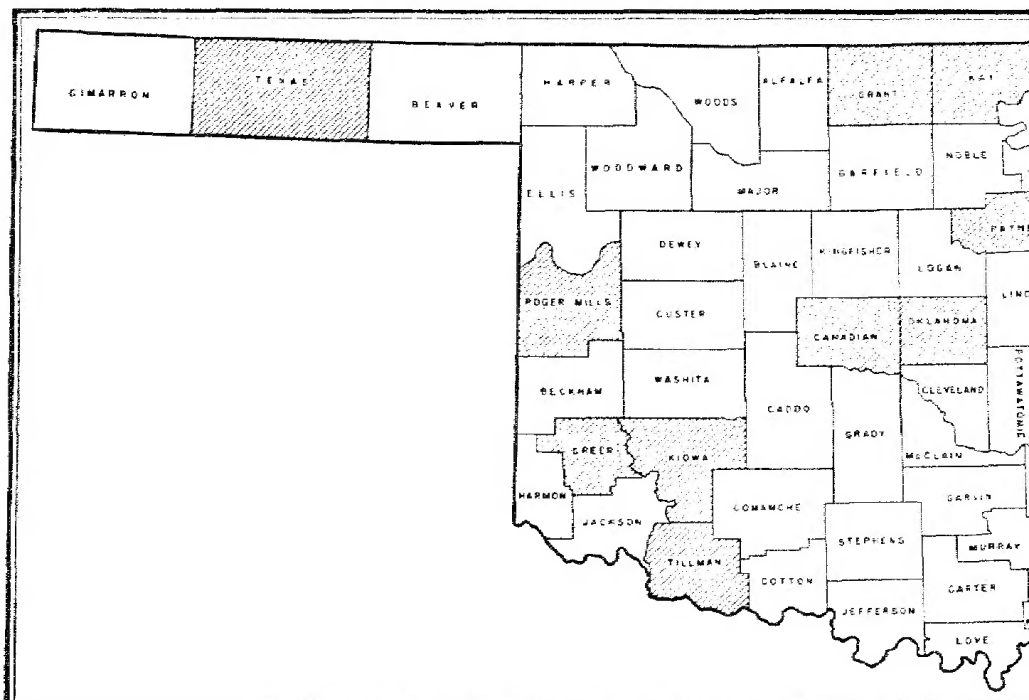
Group 6 includes several poorly drained alluvial soils in the lower parts of the bottom land along the river. The largest areas consist of Perry silty clay which has a brown surface soil and a gray subsoil. This soil occurs chiefly along Deep Fork. Lightning silty clay loam, a darker slightly better drained soil, is associated with the Perry soil. Small spots of poorly drained soils in depressions in the river bottoms are included with this group. These are Lincoln very fine sandy loam, poorly drained phase, and Verdigris soils, undifferentiated, depression phase. With better drainage, these soils would be productive.

Group 7 consists of upland soils entirely unsuited to cultivation. These are Hanceville stony loam, Talihina clay loam, Talihina stony clay loam, Parsons very fine sandy loam, eroded phase, and river-wash. These soils are too thin, too steep, or too stony for cultivation.

Much of the sloping land under cultivation in this county is being injured by erosion, and on some farms some fields are too severely eroded to allow satisfactory cultivation. Such erosion can be prevented by proper management, adapted to the various soil types.

Authority for printing soil survey reports in this form is carried in the Appropriation Act for the Department of Agriculture for the fiscal year ending June 30, 1933 (47 U. S. Stat., p. 612), as follows:

There shall be printed, as soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than two hundred and fifty copies shall be for the use of each Senator from the State and not more than one thousand copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.



Areas surveyed in Oklahoma shown by shading. Detailed surveys shown by northeast-

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U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
SOIL SURVEY DIVISION, CHARLES E. KELLOGG, CHIEF.

SOIL MAP
McINTOSH COUNTY
OKLAHOMA

OKLAHOMA AGRICULTURAL EXPERIMENT STATION
C. P. BLACKWELL, DIRECTOR
AGRONOMY DEPARTMENT
N. E. WINTERS, HEAD OF DEPARTMENT

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

- City or Village, Roads, Buildings, Wharves, Settles, Breakwater, Levee, Lighthouse, Fort
- Secondary roads and Trails
- Railroads, Steam and Electric
- Bridges, Ferry
- R.R.crossings, Tunnel
- Ford, Dam
- School or Church, Cemeteries
- Mine or Quarry, Mine dumps, Made land
- Bluff, Escarpment, Rock outcrop and Triangulation station
- Stony and Gravelly areas
- Soil boundaries
- Boundary lines
- Boundary lines
- Boundary lines
- U.S township and section lines

RELIEF
(Printed in brown or black)

- Contours, Depression contours
- Prominent Hills, Mountain Peaks
- Sand, Wash, and Sand dunes
- Shore and Low water line Sandbar

DRAINAGE
(Printed in blue)

- Streams
- Lakes, Ponds, Intermittent lakes
- Intermittent streams
- Springs, Canals and Ditches, Flumes
- Swamp, Salt marshes
- Submerged marsh Tidal flats

The above signs are in current use on the soil maps, but some of the signs appear in some maps of earlier dates.

LEGEND

Bates fine sandy loam (By)	Brewer silty clay loam (Bs)	Lightning silty clay loam (Lc)	Perry silty clay (Pe)	Talihina clay loam (Ta)	Verdigris very fine sandy loam (Vv)
Bates loam, Reddish-subsoil phase (Bm)	Brewer clay (Bw)	Parsons very fine sandy loam (Ps)	Ps Better drained phase	Teller fine sandy loam (Te)	Vv Colluvial phase
Bates silt loam (Ba)	Hanceville fine sandy loam (Hf)	Ps Deep phase	Stidham fine sand (St)	Te Rolling phase	Verdigris silty clay loam (Vc)
Bates silty clay loam (Bc)	Hanceville stony loam (Hs)	Ps Slope phase	Stidham loamy fine sand (Sd)	Verdigris very fine sand (Vf)	Yahola very fine sandy loam (Yv)
Brewer very fine sandy loam (Bv)	Lincoln fine sand (Ln)	Ps Eroded phase	Stidham very fine sandy loam (Sv)	Verdigris loamy very fine sand (Vl)	Yahola silty clay loam, Depression phase (Ys)
Brewer silt loam (Br)	Lincoln very fine sandy loam, Poorly drained phase (Lv)	Parsons silt loam (Pl)	Talihina stony clay loam (Tm)	Verdigris soils, *(Undifferentiated)* Depression phase (V)	River wash (Rv)

W. T. Carter, Inspector, District 4.
Soils surveyed by E. W. Knobel, U. S. Department of Agriculture, in charge, and O. H. Brending, Oklahoma Agricultural Experiment Station.

1 ½ 0 1 2 3 4 Miles
Scale 1 inch=1 mile

A. Hoen & Co., Inc.

Field Operations
Bureau of Chemistry and Soils
1933